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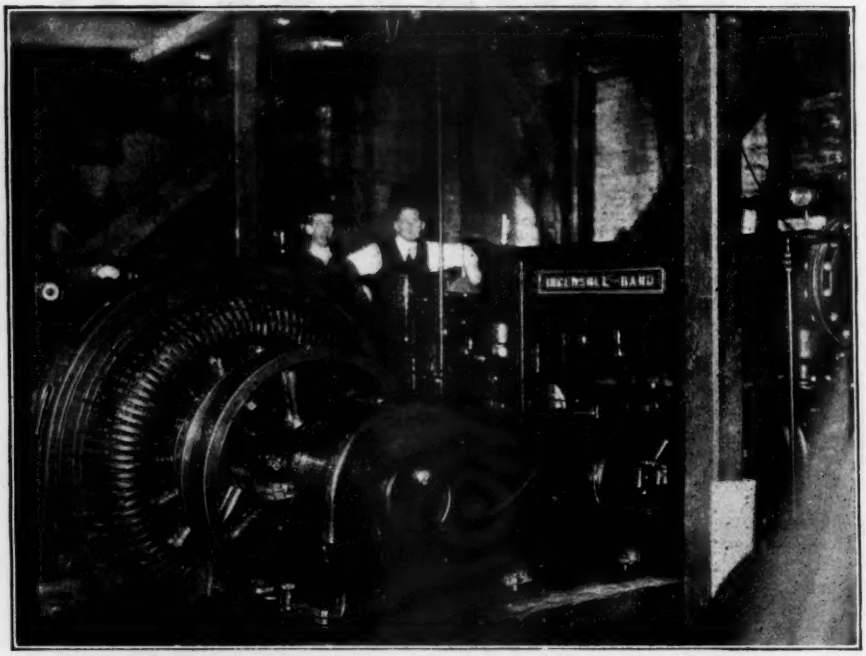
EAST RIVER WATER TUNNEL—FULL HEADING NEAR MEETING.

"HOLING THROUGH" THE EAST RIVER WATER TUNNEL

BY S. W. SYMONS.

Though the "holing through" of the water tube, joining the Boroughs of Manhattan and Brooklyn beneath the East River, was unaccompanied by the demonstration which marked the "holing through" of the Hudson Tunnel at Storm King, it nevertheless marks an event of great importance in this vast water supply system, and means that the completion of the most difficult part of the city tunnel system is in sight.

The tunnel joins shaft 21 at the foot of Clinton St., Manhattan, with shaft 22 at Sands and Bridge Sts., Brooklyn. The headings met on Sept. 27th, about 700 feet below the river level, the alignment met within 0.17 ft. and the stationing within 0.03 feet. The only officials present were the Department Engineer, Walter E. Spear, and the Division Engineer, Lazarus White, who is supervisor for this part of the work. Of the 17½ miles of city tunnel there



EAST RIVER WATER TUNNEL— ELECTRIC-DRIVEN COMPRESSORS.

now remains little more than half a mile to be excavated, and New Yorkers can look forward to seeing the whole project completed well within schedule time, the latter part of 1915.

The East River Tunnel is part of contract No. 67 handled by Holbrook, Cabot & Rollins, which begins at shaft 19 and extends to shafts 23 and 24, the two terminal shafts of the city aqueduct. This contract is distinguished from the other city tunnel work in that air pressure was required to reach rock at all the shafts, the depth of rock below ground-water varying from 36 to over 100 feet. Another feature was the step shafts at either end of the contract, which eliminated inclines. The heading north of shaft 19 and south of shaft 22 being from the upper level, and those south of shaft 19 and north of shaft 22 from the lower level, the completed tunnel is designed to drain to shaft 21, which is the deepest shaft in the whole system with the exception of those at the Storm King siphon, and besides being used as a drainage shaft, will contain a 4 ft. riser for connecting to a service pipe.

In the prosecution of the work here a good average speed has been kept up from the start, and work is progressing well within contract time.

Advantage was taken of the low cost of current offered by the Electric Companies by installing direct connected electric driven air compressors. These are of the Ingersoll-Rand PE-2 compound type equipped with intercooler and moisture trap.

At shafts 19-20-21 and 22 two machines were installed, one of 790 and one of 1108 cu. ft. capacity, making it possible to economize by running the smaller machine only when but one heading was being driven. At shafts 23 and 24, where there is only one heading, a single compressor of 790 ft. capacity was installed.

Shaft sinking after bed rock was reached, was started with drills of the Butterfly self-rotating type; at shafts 19 and 20 these drills completed the work successfully. At the other shafts Sergeant "F-94" and "E-44" drills were substituted. Shaft No. 21 was particularly difficult, due to its being a combination drainage and riser shaft and therefore irregular in section, comprising a large circle with a smaller one close by to accommodate the riser.

EAST RIVER WATER TUNNEL—TYPICAL SET-UP OF DRILLS.

The larger shaft was sunk in advance, using piston drills, the smaller shaft or riser was drilled with the rotating "Japs," and shot into the larger shaft.

Tunneling was carried on with the usual heading-and-bench method, the finished diameter ranging from 14 feet at shaft 19 to 11 feet at the terminal shafts. Progress was from 6 to 7 feet per shift; three shifts a day; drills used were mostly Sergeant "F-94" and "E-44."

Towards the latter part of the work at shaft 21 a new style of drill bit was tried out with some success. This bit was formed on round steel and was shaped like the letter "H" with the two upright bars curved to the shape of the hole, and the cross-bar raised in the center so as to pelverize the cuttings. It was found that the holes were kept a great deal more accurate and that as much work could be done on 65 lb. air pressure as on 100 lb. with the old style bit, thus realizing a large saving in drill repairs and a slight saving in power cost. This experience shows that it is advantageous to investigate different styles of bits for different rock formations.

Mucking starts generally about one hour after shooting, and continues for about 8 hours; General Electric storage battery motors are used, hauling three-car trains. At shaft 23 much water-bearing rock was struck, but was successfully handled by two electric driven pumps.

For trimming on this contract, several Ingersoll-Rand Jackhamer rotating drills are to be used. These are remarkably light machines with high drilling capacity. Concreting on this section will be carried on in much the same manner as on the balance of the rock tunnel.

Beyond the terminal shafts pipe conduits are being laid, to connect the Boroughs of Brooklyn and Richmond, a 36 inch flexible joint pipe is to be laid in a dredged trench across the narrows and covered with eight feet of silt. This will discharge into a large reservoir at Silver Lake which will make the southernmost terminal of the most wonderful water supply system in the world.

HIGH PRESSURE GAS FOR LIGHTING

High-pressure gas lighting has spread so rapidly abroad that surprise has been expressed that there has not been some progress here. A number of conditions, to be referred to later, are responsible for the unpopularity of the system in America, though undoubtedly plain inertia accounts to some extent for the neglect.

In the high-pressure scheme the pressure of the gas is raised from the normal of about 1.5 oz. to 2 lb. As a result, the temperature of the flame at the mantle is raised and the products of combustion are forced out more rapidly, resulting in an increase in efficiency—so far as volume of gas burned is concerned—of from 40 to as much as 100 per cent., depending on the lamp and the quality of gas. The reason for this great increase in efficiency can readily be appreciated from the fact that the light emitted by a mantle varies as the twelfth power of the absolute temperature.

The system naturally went through the usual stage of development and was placed on its present successful footing with the advent of the inverted type of mantle. Since 1907 its progress in application has been marvelous in England, Germany and France. Following its successful use in a large portion of the grounds of the Franco-British Exposition in London in 1908 came the rapid extension of the system for street lighting in various parts of London, until now a large part of the city of London proper is so lighted, as well as many important thoroughfares and squares.

Factory owners and commercial interests in England, moreover, have not been slow to recognize its advantages, its use by the former undoubtedly having been influenced by the industrial applications in which high-pressure gas is productive of special economies. In Birmingham a large high-pressure main has been put down, distributing gas over a large area at a pressure of 15 lb. per square inch, and while laid mainly for industrial purposes advantage is taken of it for high-pressure gas lighting, using the necessary reducing valves.

In Germany the progress has been only little slower than in England. In the city of Berlin, for example, there are not less than 40 miles of streets lighted by the new method. Quite a number of other cities in Germany are using the system, and in at least one of them a variation has been adopted of supplying the gas at normal pressure, but of feeding compressed air to the burner. Apparently the latter scheme is proving satisfactory, though data permitting of a comparison with the usual method are not available.

In the United States applications have been limited to experimental installations—some six or eight in number—at the offices of gas companies.

The first cost of high-pressure lighting when gas is obtained—as it generally is in such installations—from a plant supplying domestic and other services at ordinary pressures is obviously an item of considerable importance. Not only are the lamps of special construction, but compressors must be installed, special devices or tanks supplied for preventing fluctuations from the compressor reaching the lamps, and separate piping run. Where the system has gained such popularity that a high-pressure main from the gas plant is warranted the system is much simplified. The general method of supplying the gas is to install a separate compressor for each group, the division into groups being based on the obvious factors of number and proximity of lights, cost of laying piping, etc. In London many shop fronts are lighted from such isolated systems, the consumer paying a fixed charge for the service, the lighting and extinguishing of the lamps being entirely in the hands of the gas company.

In the maintenance cost, too, high-pressure lighting is more expensive than low pressure, so that under any given set of conditions the saving in operation must be carefully compared with the increased installation and maintenance costs. Often the two practically balance. The more expensive the gas, the more likely is the high-pressure scheme to prove economical.—*Engineering Record.*

According to the new English coal mines act, a place shall not be deemed in a fit state for working if the air contains less than 19 per cent. oxygen or more than 1¼ per cent. carbon dioxide. The percentage of inflammable gas must not exceed 0.25 per cent. in an intake airway.

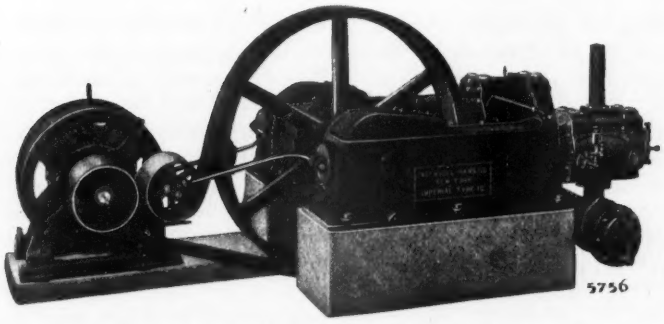


FIG. 1. COMPRESSOR DRIVEN WITH SHORT BELT.

COMPRESSORS IN CROWDED QUARTERS

The view here given in Fig. 1, of a cross-compound, two-stage, short-belt-driven air compressor, carries little suggestion of the conditions which this type of machine is designed to meet and satisfy. For all that appears in the cut, it might be located in a spacious power house with ample room to get all around it; but as a matter of fact it is really designed to work in narrow quarters, and to accommodate itself to what, if a compressor had any feelings, would be a very uncomfortable situation, to say nothing of the contortions entailed upon the man in charge who might have to get around it.

A typical installation of a compressor of this type is shown—as much as the space would permit—in Fig. 2. This is an Ingersoll-Rand, B 2, cross-compound, two-stage compressor with air cylinders 20 and 11 in. diameter and 16 in. stroke, running at a normal speed of 150 r. p. m. and compressing 850 cu. ft. of free air per min. to a pressure of 150 lb. It is at the Humboldt (gold) Mine, Ouray, Colorado, and is located in a chamber which has been cut for it out of the solid rock 1200 feet under ground, which by the way, is still more than 500 feet above sea level. It is driven by a 150 H. P. Ft. Wayne motor, the short belt drive accomplishing at once the necessary speed reduction

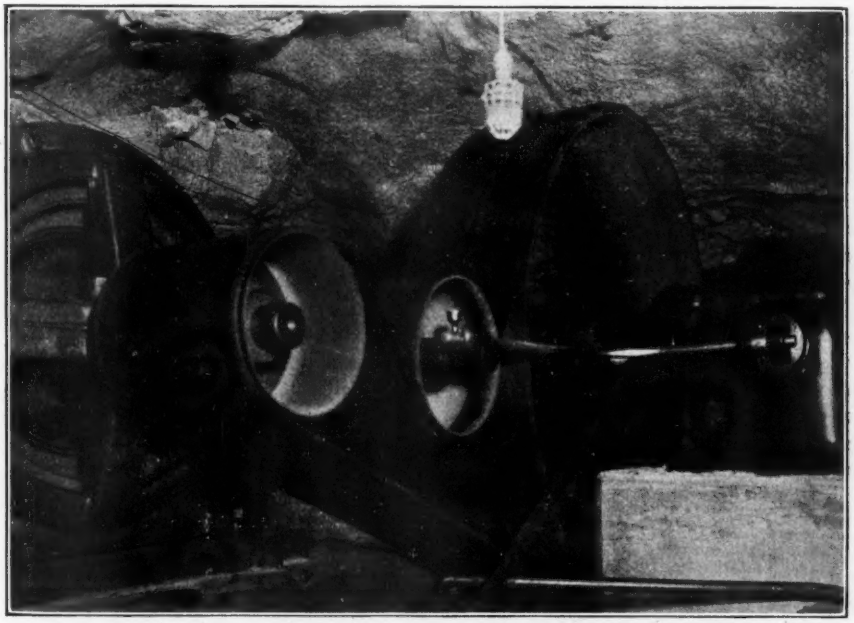
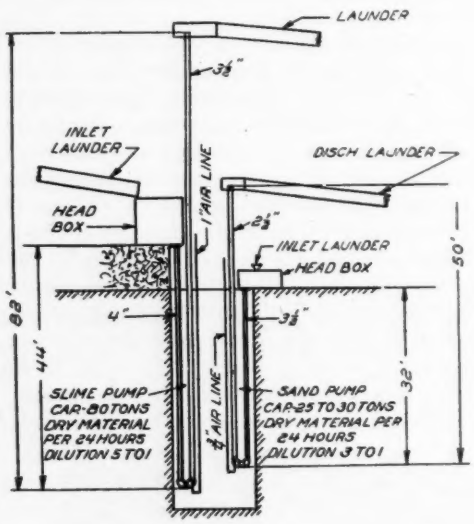


FIG. 2. SHORT BELT DRIVE WHERE IT BELONGS.

and the minimizing of the space occupied. The pull of the belt is of course on the bottom and the floating idler fully guarantees the necessary tension. The compressor has been running nearly a year, giving perfect satisfaction and requiring no care except for the necessary lubrication. The compression is done economically and the air is delivered in as good condition as it could be if the compressor might have had its own choice of location.



AIR LIFT FOR SAND AND SLIME

In a mine in Mexico, where there was considerable trouble with other forms of pumps, the air lift was finally installed to handle the sand and the slimes from the mills. Two lifts were used, one with a 2½in. lift pipe having 65 per cent. submergence, the tube discharge being lifted 18 ft. The other lift was a 3½-in. pipe with 54 per cent. submergence and an effective lift of 38 ft. It was thought best to have the well pipes of generous dimensions, and accordingly a 3½-in. well pipe was laid in the lower lift, and a 4-in. pipe in the larger one.

During two years they were looked at but once, and the repairs consisted of two nozzles and an 8-ft. length of 2½-in. pipe, for the two lifts. The lower or sand lift was plugged up at one time, but by closing the inlet or outlet and turning on high-pressure air the obstruction was easily removed. The original air pressure as figured was 25 lb. per sq. in., but better results were had with 28 lb. The consumption of air varies from 2½ to 3 cu. ft. for each cubic foot of sand or slime lifted depending on the dilution of the material. For the final lift of 38 ft., a minimum dilution of 5 to 1 is necessary to give good results. The lower or 18-ft. sand lift is run on a 3 to 1 dilution to avoid excessive handling of solution.—*Colo. School of Mines' Mag.*

GRAPHITE POWDER FOR AIR CYLINDER LUBRICATION

The Graphite Oils Co., Ltd., of Glasgow, are strongly against the use of oil in any form in the air cylinders of compressors, and to get over this difficulty they have manufactured a dry impalpable-deflocculated, air-blown-graphite powder, specially prepared for this purpose. They recommend that this dry graphite powder should be inserted in small quantities through the compressor suction inlet, and insist that the whole question of the lubrication of this part of the machinery is thereby solved. This method makes for entire safety and security from accidents, there being no danger of explosion through the accumulation of oil deposits, and no possibility of valves or cylinder faces being jammed by a carbon deposit with this form of lubrication. Another point in its favor is that it does not contaminate the compressed air which is conveyed and distributed to the various machines underground, the exhausts from which machines frequently vitiate the atmosphere of the mines.—*South African Mining Journal.*

OXYGENIZED ICE

Mr. George Leroy, director of the Ice Dealers' Society of the English Channel, Dieppe, reporting to a Committee of the French Association of Refrigeration, refers to the use of "oxygenized ice" as a conservation medium; the process being applicable to ice for refrigerating purposes only, without contact with food products. He states the process consists of adding peroxide of hydrogen or oxygenized water to the ice during its manufacture, the peroxide being incorporated by abrupt congealing. To distinguish such ice from the ordinary product, it is slightly tainted by carmen of indigo, blue methylene, etc. Besides refrigerating, this ice has antiseptic qualities.

ROCK DRILL DEVELOPMENTS*

BY W. L. SAUNDERS.

The following may be taken as a crude classification of the various types of rock drills in use to-day, the arrangement having nothing to do with the date of their successive adoption.

(1) The plugger drill. This is of the hammer type. It is used in its smallest sizes for dressing stone, for trimming, cutting hitches, and for block holes. It is a hand-rotated machine.

(2) The Jackhammer. A hammer drill with automatic rotation, used for sinking shafts, for down-hole work in stopes, for quarrying, for drilling in coal, and in rock and ore work wherever down-holes are required. It is held in the hand of the operator and in some mines is used for horizontal work, mounted upon some simple form of support.

(3) The stoper. A hammer drill with air feed, usually used without mounting and for up-holes. It has a large field of usefulness, mainly in stopes or rooms and in driving raises.

(4) The mounted hammer drill, as exemplified in the Leyner type, used mainly for horizontal, or approximately horizontal, hole drilling, for side stoping, and for driving drifts and tunnels. In this type of drill a combined stream of air and water is discharged through a hollow steel at the bottom of the drill hole.

(5) The reciprocating drill, used for heavy down-hole drilling where the stopes are large, and for surface work, drilling deep holes of large diameter.

In the last two or three years the study of rock drill economics has been pursued so vigorously and so successfully that in design, material, and workmanship the rock drill of to-day is a superior machine, doing more work, standing up to its work longer and better adapted to conditions heretofore unknown than the machines of the past. Lighter in weight, and more easily handled by the operator, it is an aid to the miner in very materially reducing the cost of ore per unit of labor, repairs, and power consumption. There has in fact been an evolution in the rock drill from a piece of steel with a bit on the end of it, struck by the hand of an operator, to a similar piece of steel struck by a power hammer. Between these two extremes we have seen the jumper, the hand-operated drill, and the power-driven machine, which started with the cumbersome rock drill of J. J. Couch, about 1850, followed by the reciprocating machine of Joseph W. Fowle a few years later, Fowle's original idea of the cutting tool being an extension of the piston rod continuing to hold supremacy in many simplified forms up to a very recent period.

It is interesting to follow the evolution of the percussive type of rock drill. We must bear in mind that there are two distinct types of power-driven machines—the reciprocating and the hammer drill. Fowle's first machine was mounted upon wheels and weighed several thousand pounds. The Burleigh drill, which was a development of Fowle's invention, was a machine mounted either upon a carriage or a tripod, but in any case it was difficult to get the weight below a thousand pounds. The struggle to reduce the weight at first met with considerable success when air pressures of from 40 to 60 lb. were in vogue. It was found, however, that it paid in mining work to use high air pressures, and this at first interfered with the efforts made by engineers to bring down the weight. There was even a period, some 20 years ago, when some engineers advocated heavy rock drills as best and most efficient in the end. Successful contractors specified large machines, claiming that by their use they were able to increase the air pressure, to get a heavier blow, to save upkeep expenses and to reduce the cost of excavation. Heavy drills invariably called for heavy mountings, and here is where an added difficulty was experienced, because heavy mountings were cumbersome underground, they were in the way, it was necessary to employ more men to handle them and they could not be used at all in narrow places. Here began the struggle for supremacy between the percussive and the hammer types,—a struggle which has recently resulted in the adoption of the hammer type as the most useful drill for general mining purposes.

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*A portion of a paper (with some re-arrangement) presented at the Butte meeting, Aug., 1913, of the American Institute of Mining Engineers.

THE MODERN ROCK DRILL.

The mining drill at the present time is a machine which weighs from 60 to 150 lb. It is largely a one-man machine, though under many conditions of work it is still best to add a helper. The percussive or piston type still holds its supremacy for heavy work, even in mines where large stopes are encountered, as, for instance, at the Homestake, but this percussive drill is now a machine which safely withstands pressures of from 100 to 110 lb. and its weight has been considerably reduced because of changes made in both design and material. This type of drill now used in the stopes at the Homestake weighs 137 lb. unmounted, and mounted on column with arm about 375 lb. Its work is chiefly in downholes. Each part of the machine represents a study in material. The metal itself and the treatment it receives in the shops are both regulated in accordance with the work that each particular part has to perform. All our knowledge of metallurgy is taken advantage of in the construction of the drill. The cast iron is not ordinary cast iron. It resembles it only in that the metal is cast. The composition is made up to suit rock-drill service and the metal is treated with special reference to the work it is to do. The steel is not common steel, but it is alloyed to suit each particular part. It receives a hot, crude oil bath and it goes through many processes before it is finally coupled up with the other parts into a complete drill. Special metal and special treatment are not confined to the piston or percussive type, but they apply equally to the hammer type. In fact, it was because of the necessity for lighter weight and greater strength in the hammer type that the study of the metallurgy of the rock drill was initiated and carried to a successful issue.

The first great improvement made in the piston or percussive type having been in the metal used, this has resulted in greater strength, greater durability, and a lighter weight of machine for higher pressures. There has also been a change in design, which in the main has been confined to the valve motion. The chief aim of the designer has been to get greater speed. This means a greater number of blows, and in order to do this valves have been provided which open and close quickly and which have large ports. It is obvious that, other things being equal, a piston type of drill of large piston area will do more work than the same type of drill with a smaller area. The larger machine, which drills more, is handicapped by its weight, and when the net efficiency is figured up it has been found that it sometimes pays to get less drilling capacity with a machine which is more readily handled. Here the question of upkeep is introduced, because generally speaking the heavy type of machine costs less for repairs than the lighter type. The designer, taking all these things into consideration, has sought to increase the diameter of the piston so as to provide the drilling capacity of the heavy type with a machine of considerably less size and weight. This has in a measure been accomplished by the use of superior material and a design which shortens the piston, putting the extra bearing into the front head, where it is lighter. Through the use of a type of valve known as the butterfly a quick opening of large area is provided, thus increasing the number of strokes and thereby bringing up the drilling capacity. This has been done with no increase in air consumption that is not compensated for by increased drilling power.

Air consumption in rock drills is much misunderstood. Assuming that the piston and valves are tight, in other words, where there is no leakage, air consumption is usually dependent upon the number of strokes delivered. It is assumed, of course, that a constant diameter and length of stroke are used and that the pressure is uniform. It is plain that if we are able to utilize air or steam at 100 lb. gauge pressure for the full length of stroke, when a percussive drill delivers its blow we are going to get the best results in drilling capacity; that is, we are going to get the hardest blow that is commensurate with the diameter, length of stroke, and pressure of the machine. If this blow is too hard, that is, if it breaks the steel, destroys the bit, or creates a condition where the drill is unmanageable on its mounting, then we have the alternative of reducing the size of the machine and in this way getting lighter weight, which is always desirable when it is consistent with the other conditions. We all know that the class of rock usually determines whether or not we are striking too hard a blow, but assuming that the class of rock is uniform, or that it is determined and understood, the engineer is ob-

viously justified in providing a drill which will strike the hardest blow that the machine and the rock will stand without destructive consequences. We see, therefore, how important it is to start with a machine which has a valve motion and ports so designed that the full power pressure will follow the piston the full stroke until the blow is delivered. Having this condition, as light a machine should be used as will stand up to the work.

It naturally occurs to one that a quick-opening valve and a large port will bring about greater speed, but the question is asked, is not this condition wasteful in air consumption on the return or back stroke? It will be generally admitted that it pays to get the blow, but why should the same conditions that give us the blow obtain when the piston returns for another stroke? There are two reasons why this is advantageous. One is, that the pull-back on a piston type of rock drill is sometimes of as great importance in the long run as the blow. A weak pull-back reduces the speed of the machine, causing it to come back more slowly than it went forward, and it has the further disadvantage that holes that are not straight, or which are out of round, and where seams and other irregularities are encountered, will act to retard the steel during its reciprocations. This considerably reduces the efficiency of the machine, not only because it cuts down the number of blows delivered, but because it weakens the strength of blow. The steel is held back in its effort to reach the full stroke and a labored blow, with sometimes a shorter stroke, is the result.

Now it is quite true that in good, clean, hard rock, without seams, and where holes are drilled to reasonable depths, it might pay to save air on the return stroke. As a matter of fact, this is always done in a piston drill because the diameter of the rod must be subtracted from the piston area. The percussive piston type of drill is naturally a compounded machine which hits a harder blow forward than backward, because it has the full piston area at one end and a reduced area at the other. It is not a difficult matter to regulate this to any degree desired by increasing or decreasing the size of the piston rod or by increasing or decreasing the valve and port areas on one end of the stroke and not on the other. But every attempt to compound a piston type of drill by putting a pressure in front of the piston is a mistake. Just in proportion as a measure is introduced in the front end it would cushion or restrict the force of blow, and in doing this, as has been previously pointed out, we make it necessary to increase the weight of the machine in order to get the effective maximum blow. It is, therefore, a very dangerous expedient in the design of piston drills to attempt to compound the stroke. Reduced air consumption is easily effected at the sacrifice of efficiency. Air at 100 lb. is delivered to a percussive drill at a cost that varies from 40c. to $2 per day. To save 25 per cent. of this is all that compounding could reasonably be expected to accomplish, and this at the maximum is only 50c. a day. Experienced engineers will have no difficulty in seeing that there are many ways underground by which this and larger amounts may be lost through a machine which must inevitably be weakened in certain other directions in order to effect a small saving in air economy. Under most conditions of service it pays to conserve labor and upkeep expenses, giving first consideration to those things which cost most. A small reduction in drilling capacity, or a few idle hours, means an expense which will easily run in excess of any possible saving in air.

The hammer type of drill is a natural air saver, and it is in the design and construction of this type that air economies may be effected safely and without sacrifice. The hammer drill is essentially a machine for mines. It represents the evolution of the rock drill from the piece of steel struck by a hammer through the various stages of percussive machines back again to the hammer-driven blow upon the steel, the difference being only that the blow is a rapid power blow. A hammer drill is economical in air consumption because, in the first place, it reciprocates a light plunger which weighs only a few pounds, while with the piston drill not only must the heavy piston be thrown backward and forward at high speed, but it carries with it the steel and bit. In hammer drills the power is utilized, not in overcoming the inertia of a heavy body, but in compensating for that inertia through the high speed of a light body. A heavy mass moving slowly may give the same impact of blow as a light mass moving rapidly. The effective work done at the bottom of the hole is represented by the weight multiplied by the velocity. The same effect may be produced

by subtracting from the weight and adding to the velocity, or *vice versa*. In a piston or percussive drill, velocity is limited, while in a hammer drill it is practically unlimited, and here is where the great possibilities of hammer drills have come in.

We must always bear in mind in comparing piston and hammer drills that the piston drill is handicapped by the load of the piston and steel, which has a certain inertia difficult to overcome in our efforts to reach high speed. The stroke is necessarily short, and as the hole gets deeper this handicap of weight is increased by longer steels, so that we are driven to high air pressures in order to get high speed. High air pressures naturally cost more money than low air pressures, and, as has been shown, if we attempt to save air by compounding we limit the capacity of the drill to force itself through difficult places.

In holes at or near the horizontal there is always an added disadvantage in a percussive type of drill, due to the steel dragging in the hole. This will take place even in a clean, straight, round hole. The steel sags, and in sagging, and during the process of rotation, there is considerable friction loss within the hole. All this leads us to high pressures, which is only another expression for greater power. It is safe to say that the piston type of drill has reached its limit when we consider capacity as a limitation when rating efficiency. In down-hole service, especially for deep holes and in soft rocks, piston drills will always be useful. The pumping action of the bit serves to agitate the material at the bottom, especially when mixed with water, and in this way the hole is kept more or less clean under the bit.

HAMMER DRILLS.

The study of rock-drill economics has led the mechanical engineer into the hammer-drill field as one which offered the greater possibilities. The problem was to do more work and with a lighter machine. The next consideration was to accomplish this with a reduced labor and power cost. All of these conditions have been met and, as subsequent figures will show, extraordinary results have been obtained which have materially reduced the cost of excavating rock and ore. We have seen that the process has been one of return to primitive methods. In other words, we have done what is most natural; and that which conforms closest to the laws of Nature is invariably best. The natural way to drill rock is to strike a piece of steel with a hammer. The only reason why the miner does not continue to do things in this way is because he cannot strike a sufficient number of blows. Just in proportion as he uses a heavier hammer does he reduce the number of blows that he is able to maintain and with the lighter hammer he is brought to an absolute limit. It would seem that the first thought of the engineer would have been to follow the old miner by building a rock drill on the hammer type. He may have thought of this, but the problem proved to be a very difficult one. The first difficulty was to get material that would stand up against this rapid-fire system. Then came the question of rotation, which was not easy to accomplish with a machine of the hammer design.

Of equal importance was the question of keeping the bottom of the hole clean, because the bit, being practically stationary at the bottom, the cuttings from the hole would pack between the edges of the bit and the bottom of the hole and prevent further progress. Jets of steam, of air, and of water were used to discharge the cuttings. Steam has many disadvantages, air is expensive and it creates dust, while water is, in the first place, difficult to introduce into the bottom of the hole, its mixture with parts of the drill results in wear and tear, and to use much water is a disadvantage and an expense in underground work. Up-hole work offers less difficulties for hammer-drill service than any other. The cuttings drop by gravity out of the hole and the only disadvantage is dust. Horizontal hole work is that which is most difficult, while with down-holes water thrown into the hole always serves a useful purpose. A mixture of air and water has solved most of the problems arising from the use of hammer drills in mines. This is known as the Leyner system. Air is always available and is readily conducted into the hole, using either live or exhaust air. Where this air is commingled with water it discharges the cuttings from the bottom of the hole without blowing them away in the form of dust, but by simply reducing them to a puddle condition with enough water only to create a moderate stream, which discharges the cuttings through the orifice of the hole. This keeps the bit cool, there is enough puff to the

air to remove the chips, and a long experience under all conditions of service has demonstrated conclusively that a mixture of air and water is more effective in cleaning the hole than even a large stream of water alone. In fact, air is the ideal thing to use, and it would be used alone were it not for the dust, so that the present system introduces only enough water to lay the dust. In doing this we effect economies by using only a small amount of water mixed with air from the exhaust.

The pneumatic tool, especially the type known as the riveter, illustrates the mechanical principles involved in the hammer drill. It is likely that the perfection of the pneumatic tool led to the perfection of the hammer drill. A riveter combines an extraordinary amount of power. Its efficiency is very high because the hammer speed is high, and the machine is light and easily handled. Its use in steel and iron construction is now universal. Air consumption in a tool of this nature is low in proportion to the work it does, because the thing reciprocated by the air is so light that it is easy to get high speed without sacrificing power to overcome inertia. In other words, there is a closer relation between the air pressure and the speed of hammer, with the resultant effective blow.

A point not to be lost sight of is that the rapid reciprocation of a flying piston, as in a hammer drill, is very much more easily mounted or held by an abutment than where we have a reciprocating action of a heavy weight, as in the case of a piston drill. The reasons for this are obvious. High speed of a light hammer takes the place of slow speed of a heavy hammer. One is like the rapid reciprocations of a hand hammer, the other the ponderous swing of a sledge. So great an effect is obtained by this rapid, light blow that it has been found practicable to reduce the weight to a figure considerably under 100 lb. in a machine which in drilling capacity compares favorably with a piston drill of two or three times the weight. In this light machine, material alone has not enabled us to cut down the weight, but the light rapidly moving piston design, with the quick-opening valve, is of equal importance. It would surprise a drill runner of 10 years ago to learn that hammer drills are used to-day in hard rock, putting in holes 10 and 15 ft. in depth without even mounting the drill, it being held in the hand of the operator. Of equal importance in tunnel driving is the fact that by the use of hammer drills the equivalent of heavy machines is placed in the headings mounted upon a light horizontal bar, this bar being easily handled by a few men, yet it affords abutment enough to resist the jar, because the jar has been reduced to a minimum. Heavy upright columns, carriages, and other forms of support were made necessary because of the ponderous pulsations of the piston drill. To be able to use a light bar, placed horizontally, is of the greatest importance in tunnel driving because it affords an opportunity to begin drilling quickly after a blast and before the muck has been cleared away from the bottom of the heading.

An effort has been made in the foregoing statements to analyze and give reasons for a condition in rock-drill service which is now in practical operation. A hammer drill is the modern progressive miner. It has practically done away with hand drilling and in doing this it has largely increased the field of service. There is no longer any question about the fact that it pays to use power drills in all classes of mining. It is now entirely a question of adapting the system of mining to these light, efficient, handy perforators.

In August, 1912, there was held at Calumet, Mich., what is perhaps the last contest between hand and power drilling. A three-man double-jack team of the best drillers in the copper country were pitted for a money prize against a small hammer drill of the Butterfly type. This machine was operated by one man. The drilling was in a block of Cape Ann granite, 60 in. thick. The three-man drilling team started with a 1¼-in. bit and finished with a ⅞-in. bit. The one man with the Butterfly (this is a light hand hammer drill, of the usual plugger type, weighing about 40 lb.) used a 2-in. starter and finished with a 1¼-in. bit. It required 14 min. for the machine to drill entirely through the block (60 in.), while the hammer-and-drill squad put in a 49-in. hole in the same time. The machine thus did 20 per cent. more work with one-third the labor cost. As a matter of fact, no such rate of hand drilling as was shown by the three-man squad could be maintained over a working shift, while there is no reason why the machine drill should not keep up its speed indefinitely.

FUEL OIL SERVICE IN NAVY YARD FORGE SHOPS

F. G. Coburn, Assistant Naval Constructor, United States Navy Yard, Philadelphia, has written for the American Machinist an interesting account of the use of fuel oil in the navy yard of the United States. It is not only interesting but conveys valuable and reliable practical information concerning an important industrial development. The report is reproduced here in somewhat condensed form.

Those who have had experience with both coal and fuel oil as forge-shop fuels are agreed, practically without exception, that oil is far superior to coal. Water gas and producer gas are being thought of for this purpose, also pulverized coal, but the cost of any one of these is still prohibitive as compared with oil, and the cost of oil is still low enough to be attractive. So that for the present, and probably for some time to come, fuel oil must really be considered the ideal forge-shop fuel.

Fuel oil has had a broad field opened to it in the past ten years, and interest in the development of its use has been very general. This interest has been chiefly shown in the development of the oil furnace, not only for forging, but for a great many other purposes; so that a great many industries have been instrumental in working it out.

The United States navy yards have been closely connected with the development of oil burning, and have been very consistent in their adoption of it. All the navy yards now use fuel oil in their forge shops; in many of them to the complete exclusion of coal. The adaptation of fuel oil to the blacksmith's open forge is particularly a navy-yard development whose importance and value have not yet been thoroughly recognized by the commercial world.

DIFFERENT INSTALLATIONS.

No two of the navy yard installations are identical, and some of them differ widely from others. The differences between these installations show in a very plain way the different ideas as to how oil should be burned in the forge shop, and seem to point out to an investigator the ideal method.

In a general way, it may be stated that the differences in methods hinge on the method of breaking up the oil and mixing it with air preparatory to burning it. This, of course, has to be done mechanically, either by the impact of air or steam jets, or by a spraying nozzle, relying on the pressure under which the oil is supplied, or by a combination of these methods.

If a spraying nozzle can be used, together with an air supply under fan pressure (6 to 8 oz.), the cheapest method results. This can be done readily in furnace installations, as is amply proved by experience; and where furnace installations only are required, no other method should be considered.

Where open forges, flanging forges, etc., are required, it has been found that this method is not satisfactory, because it is impracticable to break up the oil and burn it fast enough to heat with sufficient rapidity. One year ago this statement would have withstood any attack; but within this last year, at least one such installation, and perhaps two, have been developed with promises of success.

STEAM JET ABANDONED.

Experimental work and actual practice up to that time, however, had shown the necessity for positive and quick breaking up of the oil. This was at first done usually by a steam jet, but this practice was abandoned because of the expense of installation, waste of steam, and waste of heat applied to raising the temperature of the steam in the flame. It was also very noisy.

This method was early supplemented by the use of air at high pressures—usually near 100 lb.—for atomizing. This installation was quite as expensive to put in as the steam atomizer equipment, was just as noisy and just as expensive to operate, but it showed a saving in heat, because the air was applied for combustion. Neither of these methods is in good repute any more.

PRESENT METHODS OF BURNING OIL.

At present there are three well recognized methods of burning oil, using air, as follows: (A) A combination of an atomizing air jet of about 20 lb. pressure and a supply of air for combustion under low pressure (fan blast). (B) A medium pressure of air, about 4 lb., for atomizing and combustion. (C) A fan blast only. The last method is success-

ful for furnaces, and should be employed where furnaces only are in use. It is hoped that it will soon be successful for open forges. The first two methods are successful both for forges and furnaces.

Two general types of burner must be recognized in connection with the above: the closed type, Fig. 1, and the open type, Fig. 2. In the closed burner all air, whether for atomization of the oil, must come from fan or blower or compressor through the mains to the burner, and no other air may be admitted.

In the open burner the injector action of the burner is relied on to pull in enough air from the surrounding atmosphere, through suitable apertures, to provide, with the atomizing jet, for complete combustion of the oil. It must be apparent, all other things being equal, that the open type burner is better than the closed type, as it requires less power to compress its air. This power saving is nearly 50 per cent.

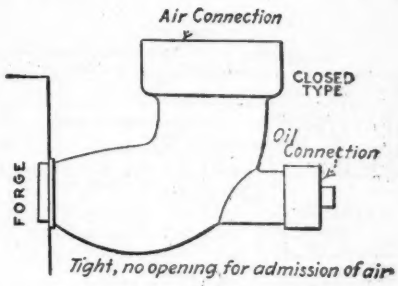


FIG. 1

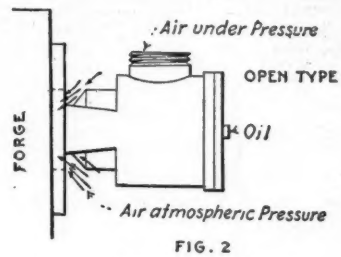


FIG. 2

TYPES OF BURNERS.

TYPES OF BURNERS ADOPTED.

About eight years ago the investigation of oil fuel for the open forge was taken up at the navy yards at Norfolk, Va., and Mare Island, Cal., and within a year oil fuel in the forge shop was a success at both places. At Norfolk a combination burner, type A., is used, a closed burner, taking compressed air at about 20 lb. for atomizing, fan blast for combustion, and oil at about 20 lb. pressure. At Mare Island a type B, open burner, was developed, taking air at about 4 lb. for atomization and partial combustion, the inspirator action serving to provide sufficient air to complete the combustion.

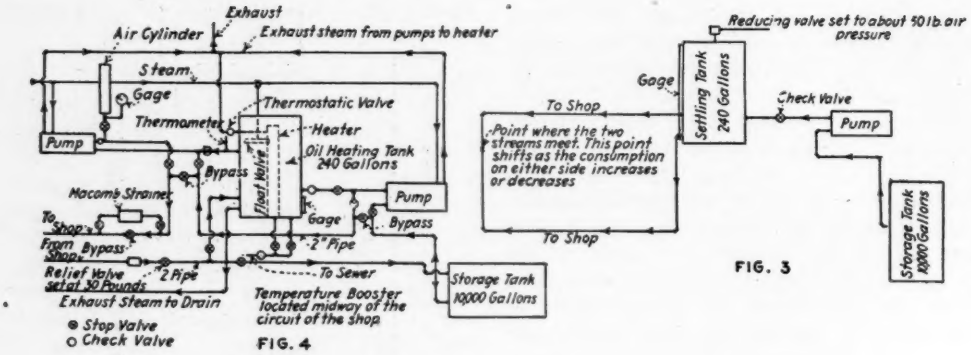
At the New York yard there still remain some forges using air at about 90 lb., but the furnaces are being arranged for fan blast, type C burners, as are the forges, the latter being in the nature of experiments. This yard has always been experimenting with oil fuel, and a great deal has been learned there. The oil installation there is not, however, quite so complete as at other yards. At the Portsmouth, N. H., navy yard a medium pressure, type B, closed burner, is in use, and its application is complete. All furnaces and forges, whether for solid, angle or plate work, use oil successfully.

At the Philadelphia navy yard the medium pressure, type B, open burner, is installed, and here again the oil installation is complete, no coal fires for any purpose being used in the forge shop. This installation is in all essentials like that at the Mare Island yard, as is also that at Puget Sound, Wash., and all three are entirely successful. At the Boston yard the type A, or combustion burner, has found favor, so that the installation there is essentially the same as that at Norfolk.

In general it may be said that the navy yard experience indicates the desirability of the low pressure (type C) installation, and that it is successful now for furnaces, but when a large proportion of the work must be done at the open forge, as is the case in navy yard forge shops, some more positive methods must be used in order to get a sharp enough fire; and here the general opinion, as indicated by practice, points to a medium pressure, open type burner.

HANDLING THE OIL.

When the study of fuel oil was taken up, oil was very cheap, and a light gravity oil was obtainable. One of our largest Western railroads did, in fact, decide that it did not pay to use an oil heavier than 25 deg. Baumé. Thus, the Eastern yards met with no difficulties in handling the oil in the shop, in getting it to the burner ready to burn. They employed an arrangement similar to that shown diagrammatically in Fig. 3, which



OIL ST ORAGE.

consists of a large storage tank, a small auxiliary tank for measuring and settling, and a loop around the shop for the oil, air pressure serving to supply it.

But when the early work was started on the Pacific Coast, it was found that to burn the oil obtainable then, which ran 14 to 18 deg. Baumé, and had considerable water in it, a more complete system was needed. Fig. 4 shows, diagrammatically, the method that was developed. An auxiliary tank for settling and heating the oil (to make it limpid), with a circulating pump to keep hot oil moving through the mains constantly, comprises the apparatus. This circulating pump maintains a pressure of about 50 lb. in the oil line, the excess oil passing through a relief valve set at 40 or 45 lb., back into the settling tank, the level in which is maintained constant by a supply pump, controlled by a float valve in the tank. This arrangement is really less complicated than the diagram suggests.

Of late years, the fuel oil supplied to the Eastern navy yards has been heavier than at first, but the old oil installations worked satisfactorily enough because knowledge of burning oil has increased. However, I have found that the oil-heating and circulating system is worth putting in, even now, and I look to see it more generally adopted. The oil should be heated to not less than 140 deg. F., and booster heaters put in along the line to keep the temperature from getting below 120 deg. F., if practicable, as this gives the best results. At Mare Island and Philadelphia the arrangement shown in Fig. 4 is installed; the other yards are fitted out like Fig. 3.

AIR FEED FOR PNEUMATIC DRILL

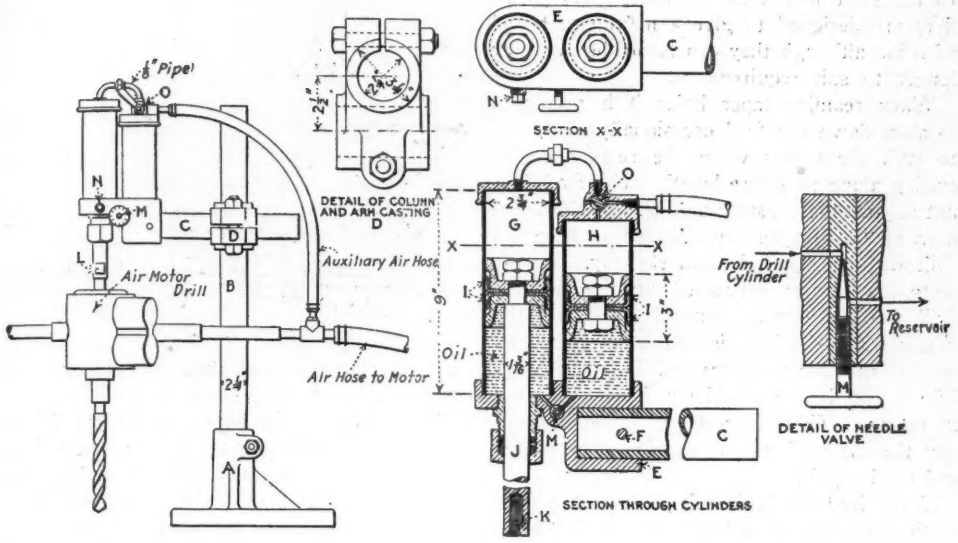
BY NELSON B. HENRY.

The feed mechanism and drill stand here described were designed to be used in connection with an ordinary air drill and is strictly a portable outfit.

The drill stand or "Old Man," consists of a base *A*, a column *B*, an arm *C*, and a clamp casting *D*. The arm and column are made of 2-in. hydraulic pipe finished on the outside to 2¼ in. diameter and of such lengths as may be required. The base is slotted and provided with a clamp bolt so that the column may readily be removed in case one of different length is necessary. The clamp casting also is slotted and has two clamp bolts, so that the drill may be adjusted as to height or the arm may be partially rotated for drilling at an angle.

A casting *E* is pressed on the end of the arm *C* and held in place by a pin *F*. This casting is recessed and threaded to receive the drill cylinder *G* and the reservoir cylinder *H*. Both cylinders are made of brass tubing such as is generally used for the working barrel of a deep-well pump. Each cylinder is closed at the top by a brass cap screwed in place.

Brass pistons fitted with double cup leathers *I* work in the cylinders. The piston in the drill clyinder is fitted with a $1^{3}/_{16}$ in. steel rod *J*, internally threaded at the lower end *K* to receive the stud in the top of the air motor from which the hand feed star nut has been removed. Flats are cut in the rod at *L* so that a wrench can be applied in connecting up the air motor to the rod. The rod works through a brass stuffing box and nut at the



bottom of the cylinder as shown. The piston in the reservoir cylinder has no rod, being held together by a short bolt.

A four way valve *O* is made integral with the cap on the reservoir cylinder and serves to admit air under pressure at the top of either cylinder. An exhaust hole is drilled in the side of the valve so that when either cylinder is under pressure the other is open to the atmosphere.

In the casting which forms the bottom of the cylinders, and midway between them is a needle valve *M*. The valve casing is made of drawn brass rod and after being machined is pressed into place. Holes are drilled at an angle in the casting so as to intercept the valve casing above and below the seat. The valve proper is made with a very slight taper so that several turns of the hand wheel are necessary to open it appreciably. No stuffing-box is needed for the valve stem as the greatest pressure (from the drill cylinder) comes below the valve seat. The hand wheel is graduated so that it may be accurately readjusted to any desired opening of the valve.

The lower portion of the cylinders under the pistons is filled with a light oil such as is used by hydraulic jacks. Care must be taken to see that the proper quantity of oil is put in the cylinders or the full travel of the piston rod carrying the air motor will not be available. In order to do this, place the cylinders in an inverted position, push the piston rod to the top of the cylinder, open the needle valve *M* several turns and pour the oil slowly through the plugged hole *N*. When full, screw the plug in place and pull the piston rod as far out as possible. This will serve to shove the piston in *H* to the top of the cylinder. Now remove the plug *N* and continue to pull out the rod until the piston strikes the bottom, allowing the surplus oil to overflow. Replace the plug and the mechanism is ready for use. It is very important that no air be trapped in the cylinders under the pistons and the method of filling outlined above obviates this difficulty.

Connect the auxiliary air hose to the motor hose as shown. Turn on the air, start the motor and set the four-way valve so that the top of the cylinder *G* is under pressure. The piston in *G* will be forced downward, pushing the drill with it, at a rate of speed dependent upon the opening in the needle valve. It is, of course, obvious that the "feed" can be varied to suit conditions by opening or closing the needle valve. The oil escaping through the valve into the reservoir cylinder raises the piston therein. After a hole has been drilled, reversing the four-way valve causes the oil in *H* to be forced back into *G*, raising the drill out of the work. This last operation only takes a second or two if the needle valve is opened wide.

With the size of cylinder shown and 90 lb. air pressure, about 500 lb. may be applied

to force the drill into the work. The cylinders are designed to give a maximum travel of 6 in., although they can be made larger or longer to suit requirements.

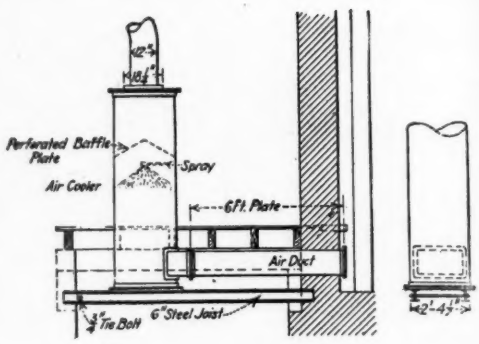
When reaming taper holes it is necessary to slow down the feed occasionally so as not to stall the motor when the reamer begins cutting along its entire length. The feed does not require the constant attention of the operator, and it may be depended on to keep the drill working up to its full capacity. As the motor is always supported by the oil, the drill will not gouge through and stop the motor when the hole is nearly completed as is often the case when the drill is fed by hand. The outfit is comparatively light and easy to set up. There is practically nothing except the cup leathers and packing to wear out and need repairing.

If the feed mechanism is always used in a vertical position or only slightly inclined, the piston in the reservoir cylinder may be omitted and the air pressure allowed to come directly on the surface of the oil when reversing the feed.—*American Machinist.*

A COMPRESSOR PRECOOLER AND AIR SCRUBBER

The illustration here reproduced from *Engineering and Mining Journal* shows a device employed by the Broken Hill South Silver Mining Company in Australia. It consists of a cylindrical upright cooling shell with a horizontal duct leading from the outside air; the duct is made of sheet steel and has a rectangular section. The free air enters at the right hand end of the duct and rising through the cooler is met by a downwardly directed spray of water from a cooling tower. The effect of this is to reduce the temperature of the air and at the same time to wash out all dust and foreign materials.

Getting the free air to the compressor, and into the compressor, as cool and as clean as possible, cannot be too much insisted upon, and the device here shown is to be commended, at least for the intention embodied, although it would seem to be hardly as efficient as it might be for the complete accomplishment of its purpose, and there is the additional objection that it would seem to be too elaborate and expensive, so much so that it might tend to deter some from precooling



and filtering their air when they surely ought to do so.

The apparatus as shown could not fail to have a good effect upon the air, but neither the cooling of the air nor the cleaning of it by the removal of the dust in suspension can be done instantaneously at one point of its flow for each operation as here indicated. If the upright shell had been entirely filled with some loosely packed porous material such as coke, and if there had been provided at the top a little stream of water sufficient to keep the coke constantly saturated, and if the air had been so piped as to flow up through the body of coke in a leisurely way it would have been cooled and well cleaned. It would be necessary to wash the coke occasionally by sending through it a strong stream of water, or the coke might require renewal.

But a much cheaper and a very effective device was described in COMPRESSED AIR MAGAZINE some time ago (June, 1911) and it would seem to be proper to again call attention to it. In this case there was a vertical pipe, of sufficient capacity to liberally supply the compressor intake, standing say a foot above the ground with a hood over it not interfering with the air flow but keeping things from dropping into it. This pipe was outside the compressor room and was continued under ground to connect with the compressor intake inside.

Well, over this pipe was set a wooden frame of cubical outline, measuring, say, a yard in each dimension and made of wood stuff about 2 in. square, and this was covered all over—except the bottom—with burlap, both inside the frame and outside, making two thicknesses of stuff for the air to pass through. To complete the rig there was suspended over it a revolving lawn sprinkler and a lit-

tle stream of water sent through it kept all the burlap wet all the time.

This gave very satisfactory results and it happened to be located in one of the dustiest and hottest regions in the United States. When the burlap became choked with the dust, as frequently happened, the frame was lifted off and thoroughly soused, both inside and out, with water from a hose, which in a few minutes made it as good as new.

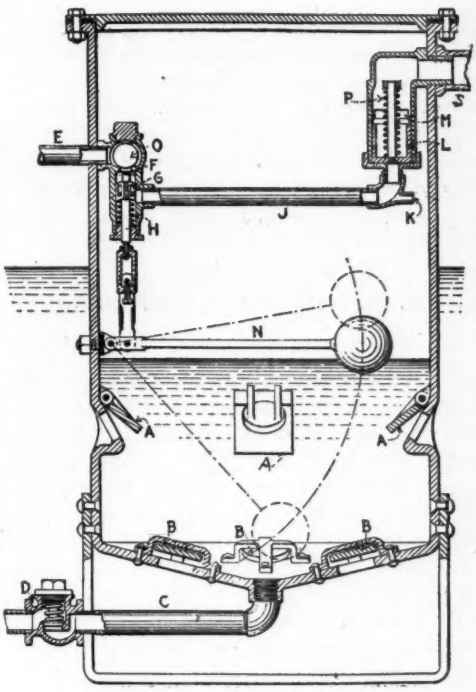
It scarcely needs to be remarked here that the dampening of the intake air by this or any other device has no effect upon the quantity of moisture in the air after compression and ready to be used, because in any case where air is compressed to six or eight atmospheres and recooled to normal temperature, it will have more water than it can carry, and arrangements must be made for draining it, or for allowing it, as we might say, to dry itself, which matter it is not necessary to discuss here, as the practice should be already familiar to our readers.

AN AUTOMATIC AIR OPERATED PUMP

The sketch here reproduced from *Power* shows the essential features of a pump of interesting design which has been in operation for some time in the mine of the Pittsburgh & Southwestern Coal Company, Avella, Pa. It is the invention of Edwin Chamberlin and A. M. Gardner, Avella, Pa., who have applied for a patent on the device.

The body of the pump is a vertical cylindrical tank adapted to be submerged, or partly submerged, in the water to be elevated. It is provided with water inlet valves A and B, four of each. A water discharge pipe C is connected to the bottom of the tank, and a spring-controlled check valve D prevents any return of the water.

Compressed air of sufficient pressure is admitted by pipe E, being normally held back from entering the chamber by the ball valve O upon the valve seat F. With things in the position shown in the sketch, the valves A and B being open, water may be assumed to be entering the chamber and the float and arm N is rising. As it rises to the dotted position, the adjustable upright connection H and Plunger G will lift valve O and air will rush into the chamber by pipe U and the opening K. This rush of compressed air will also raise valve L to cover ports M by which the air in the chamber has been escaping to the atmosphere, leaving by the pipe S.



AUTOMATIC DIRECT AIR PRESSURE PUMP.

The filling of the chamber with compressed air will drive the water down and out, the float falling as the water recedes and when it has fallen to about the position indicated in the sketch valve O will again be seated and the admission of air will cease, while the water will continue to be driven out by the expansion of the air in the chamber. When the pressure has fallen so that no more water is expelled the same decrease of pressure will allow valve L to descend, uncovering ports M and discharging the air to the atmosphere until all surplus pressure is lost when the tank will begin to fill with water, the above recited cycle of operations will be repeated, and so on continuously.

It would seem that the best that can be said of the above described device is that it will actually work. Some inventions will not even do that. The filling and emptying of the large chamber with compressed air, only a small part of the pressure of which can be availed of, entails a great waste of air. This

can be minimized by the proper adjustment of the float-controlled movements, but these apparently can only be changed by the removal of the big cover, which is an operation not inviting frequent repetition. When valve O is first lifted and before the ports M can be covered there must be opportunity for some air to blow through without doing any work at all.

ACTUAL EFFICIENCIES IN ROCK DRILLING

BY LETSON BALLIET.*

But little attention has been given to the actual time that pneumatic rock drills are cutting the rock. Careful investigation of the actual time that rock drills are using air brings forth some very startling figures. In fact, I may say they are actual surprises. The most startling fact is that the drills are cutting, using air, only about one-third of the time. There are places in hard rock, where a drill will stand and pound for more than one-third of the time, but there are other places where time will be lost to make up for it. Any period of three or six months, with a flow meter on the air will show but little variation from the tabulated figures.

"Lost lights," candles blown out by drill exhausts, or by leaking hose, or leaking connections, or when blowing holes, or put out by dripping water, or by being dropped, is variable but can safely be estimated at 2 to 3 per cent. of the time, when counted by the month. "Stuck drills" is variable loss of time, and might be estimated as reducing it another 3 per cent. though, in some ground, there is very little loss from this cause, while in other places there is considerable. In making the above figures in the table we were making our primary attempt at getting drill data, and since making them several points for study have arisen in our minds.

In making the table of figures herewith, the author took as a basis the wage scale at Tonopah, Nevada, which is $4.50 per 8-hour shift for machine drillers, if the mine is dry, and $5, if it is wet. Including the lost time of going in and coming out on company time, and the average between $4.50 and $5 per day, it is fair to assume that drill runners' pay in Tonopah, is practically one cent per minute—as 8 hours of sixty minutes each contain but 480 working minutes for the shift. Therefore, to adapt these figures to other wage scales, it is only necessary to reduce the wage scale to "pay per minute" for drill runners.

Work—	Time. Minutes.	Per Cent. of Time.	Cost.
Setting up machines.....	82	17	$0.82
Shifting machines	66	14	.66
Changing steel	75	15	.75
Morning and noon starting.	24	5	.24
Oiling and cleaning.....	15	3	.15
Getting steel and water....	15	3	.15
Tearing down and blasting.	45	9	.45
Actual time drilling.....	158	34	1.58
Total, 8 hours, or.....	480	100	$4.80

In the above table we have computed only one man to each drill, whereas, if more than one man is employed, the cost would be increased by the additional man or men. Muckers, trammers and compressor operator are not included in these figures. These figures were made with the mine operated by two shifts of eight hours each, allowing four hours between shifts for blowing smoke. If a mine is operated with three shifts, 5 per cent. additional loss is necessary for time to "eat on shift, get a drink and get started again" and 6 per cent. will be lost "blowing smoke."

Thus, on a two-shift basis, little more than 2 hours actual drilling can be depended upon, while considerably less than 2 hours can be credited when three shifts are employed.

It must be remembered that no criticism nor complaint can be charged to the miner, or drill runner, for in the above table we have given him credit for a full 480 minutes, doing something. We haven't charged the miner with a single minute of soldiering, nor wasting any time. He is working, doing all he can do, and if the drill operation is inefficient it is not his fault. Look at the table, and notice that "going to the end of the air pipe for air" and "rolling cigarettes" is not mentioned. If there is a fault or criticism to fall on any one's shoulder, because drills are inefficient, it is to fall upon the "engineering head" that planned the method of working and not upon the laborer who is doing the best he can with the equipment that is furnished him.

*Buckeye Mine, Tonopah, Nevada.

The loss, of 66 per cent. efficiency in machine drilling is not confined to the loss necessary in paying men to do "dead work" on a drill, or the pay roll loss to the miner, it goes clear back into your power bills, superintendence, interest on out-laid capital, and overhead costs. For example, let us assume, on a basis of 4 cent per kilowatt-hour for electric power, that it cost 90 cents per hour to keep a compressor running, to carry two ordinary drifting piston machines running. On the basis of 2½ hours efficiency out of eight, the compressor cost $7.20 a shift to keep running, whereas the drills use only $2.25 worth of the power time. It is evident that $4.95 has been donated to the power company, but the power company is not to blame. Manifestly, this loss is not up to the power companies, nor to the manufacturers of drills, nor to the manufacturer of compressors, nor to the laborer. Any big mine could well offer a reward, or bonus, for a plan that would increase the drill efficiencies. There is no chance for the responsibility of this inefficiency to be shifted; it is up to the engineering head, and management of each individual mine.

The question now arises "How can the efficiency of drilling be increased?"

First—Be sure that the drillers have a clean set-up. Muckers can clean out, so that $4.50 and $5-a-day-men don't have to do $4-laborer's work.

Second—Give the men good ventilation, so that they will not have to go to the end of the air pipe for a breath of air, and so that they can work without becoming fatigued and exhausted at the slightest exertion.

Third—Provide them with good cool drinking water, so that they will not have to go clear to the station for a drink of water that may then be luke-warm.

Fourth—Provide them with drilling water, and necessary lubricants so that they will not have to be leaving the face to procure them.

Fifth—Provide them with plenty of steel and tools, so that they don't have to use dull steel, nor rustle tools, or wait for steel or tools.

Sixth—Last and not least, give them good light to work by. Electric lights, if possible. It pays. They can see to handle their machine, see to shift it, see to change steel, and see their work. They can take advantage of rock if they can see it, and will be safe because they can see insecure roofs, walls and timbers better. If they go to the station for a drink of water, they will save time if they walk through electric lighted drifts and crosscuts, for they unconsciously walk faster, than when groping along trying to keep a candle alight.

The writer, when sinking a wet shaft with machine drills, secured two storage batteries and made a galvanized iron box with a cover to keep out dropping water, in which he set a battery. This box had an automobile head light on the underside pointing down, and the sides of the box were equipped with hangers like a sinking pump, to hop over a wall plate or center piece. These batteries burned 6-volt lamps, weighed about 40 pounds, and run (burning) for 33 hours. These batteries in the housing were taken down every shift and hung on a timber up the shaft 15 feet or so from the bottom, and thus the bottom was flooded with light equal to the headlight of any automobile.

Thus the miners were able to see their work, in a brilliant light hanging in the manway. Exhaust air for ventilation didn't put out the lights, dripping water didn't leave them in the dark, and the men themselves said that this light saved each man more than two hours a day fooling with lost lights. Men would rather work in good light than to be groping in the dark; if you don't believe it, just listen to the profanity generated when they lose their lights. In conclusion, I want to urge the importance of good light and good ventilation, for mine efficiency. Don't kick, and don't blame the men for not getting out the rock if you don't give them a chance.

MODERN ROCK EXCAVATION DEVELOPMENTS

The construction of such works as the Catskill Aqueduct, the Panana Canal, and numerous mines and tunnels throughout the world would be almost if not quite impossible were it not for the advantage which modern men have in the use of powerful explosives.

"Gunpowder as an explosive agent was not known in western Europe until a few years before the discovery of America; and it was not until nearly 150 years later that drill holes, loaded with this explosive, were used for breaking rock in the mines in Germany. This

method was soon after introduced into England, Sweden and other countries. The practice of land drilling and loading with gunpowder was standard up to within 50 years ago, although this seems almost incredible in view of the rapid strides made since then.

"Within the last half century the whole procedure has been completely revolutionized by the invention and development of three fundamental requisites—the air compressor, the power drill and dynamite."

And these means came into industrial practice very nearly at the same time.—*Catskill Water System News*, No. 45.

OXYGEN BLAST FURNACE PRACTICE

BY GUSTAVE TRASENSTER,

(Ougrée-Marihaye, Belgium).*

For some time past the Ougrée-Marihaye Company has been carrying out experiments on the use of oxygen in metallurgy, with special reference to blast furnace practice. In order to obtain the oxygen required the company has had recourse to the air liquefaction process, deeming that, in the present state of the science, this was the only process which could be regarded as capable of yielding, in commercial quantities and sufficiently cheaply, the large amounts of oxygen that it was necessary to employ.

The system adopted at Ougrée for the liquefaction of air and its separation into its elements is that of Georges Claude, of Paris, in which liquefaction is obtained by means of great cold resulting from expansion, on doing work outside. This expansion, incomparably more efficacious than any other, is obtained with the greatest ease by driving, by means of compressed air, an expansion vessel—simply a piston working in a cylinder, very much like an ordinary steam piston. At Ougrée the pressure required for the compressed air is 15 atmospheres (say, 220 lbs. per sq. in.)

This method of expansion, in spite of its efficaciousness, is incapable of refrigerating the air to a temperature sufficiently low for its liquefaction in a single stroke; and it is by means of what may be described as a temperature transformer that the air escaping from the expansion cylinder by a tube concentric to that by which it is admitted, is able rapidly to attain the temperature of liquefaction.

The liquid air having been obtained, advantage is taken in the process described of the difference between the boiling points of liquid oxygen and liquid nitrogen to separate the two elements. The boiling point of oxygen is—180 deg. C., and that of nitrogen—195. deg. C. This separation, however, necessitates boiling the mixture, and this is effected very easily in a vaporiser; the gases resulting from the ebullition rising in a receiver, the sides of which are sprayed by intensely cold liquids—mixtures of more or less liquid oxygen and nitrogen—which effect condensation and, as a result, the almost complete separation of the oxygen in the ascending gases. Thanks to this arrangement, the apparatus allows of pure gaseous oxygen being obtained on the one hand, and, on the other, equally pure nitrogen containing at most a few hundredths of oxygen.

THE OXYGEN PLANT AT OUGREE.

This plant is capable of making 600 cubic metres of oxygen per hour. It is composed of three absolutely similar liquid-air units, each unit yielding 7,000 cub. ft. of oxygen hourly. A unit consists of:—(1) A compressor, capable of drawing in 42,000 cub. ft. of air per hour, and of compressing it at a pressure of 220 lbs. per sq. in. This compressor is belt-driven from a dynamo. (2) A liquid-air machine and tower, containing all the fittings and appliances necessary for the liquefaction and separation of the air into oxygen and nitrogen. (3) Two decarbonizing towers. It is, as a matter of fact, of prime necessity that the air drawn in by the compressors and sent into the liquid-air machine should have every trace of carbon dioxide it contains removed. With this object the air is made to pass through two towers containing brick chequerwork, which is sprinkled with a solution containing soda. (4) A battery of desiccators intended to remove any moisture contained in the air. This battery is interpolated between the compressors and the liquid-air machine, and therefore receives the air under pressure. The desiccation is effected by means of calcium chloride.

The operations are of the simplest description, and the staff is very small. The manufacture of oxygen from liquid air has become a thoroughly practical and business operation;

*Brussels Meeting of the Iron and Steel Institute.

and thanks to certain improvements with which the Ougrée machinery is equipped, it has been possible to secure continuous working.

The energy required is slightly over one horse-power for every cubic metre (35.3 cub. ft.) of oxygen. It is not possible, however, to base calculations on this figure, which, if anything, is rather too high, as, for a permanent installation, machines of larger capacity than 7,000 cub. ft. of oxygen per hour would be used. The power absorbed by a cubic metre of oxygen would diminish the larger the machines, and the makers are at present engaged in making machines to produce 35,000 cub. ft. of oxygen per hour. In these circumstances, and with the further improvements which will be made, it may even now be prophesied that with such machines the power consumption per cubic metre will fall to two-thirds of a horse-power.

EXPERIMENTS OF THE OUGREE COMPANY.

Some months ago a preliminary trial was carried out, but its duration was too short to justify conclusions being drawn. Owing to a set of circumstances quite distinct from the ultimate object of the experiments, this preliminary trial had to be discontinued, but it will shortly be resumed.

The experiments which it is proposed to carry out relate to two distinct problems:—(1) The first series of experiments will consist simply and solely of enriching the blast delivered to one of the Company's existing blast furnaces, by oxygen—that is to say, mixing with the blast for this blast furnace the 21,000 cub. ft. of oxygen available. The percentage of oxygen in the blast will be raised by these means from 20.8 to about 23 per cent. The problem to be solved is whether this degree of enrichment is sufficient to cause the anticipated phenomena to manifest themselves sufficiently distinctly. (2) Other experiments will be carried out in a small blast furnace which has been built and in which working will be carried out with very high percentages of oxygen, and even with pure oxygen. In the latter instance, should the need of so doing be felt, recourse will be had to the Oscar Loiseau process, and the intense heat will be reduced by introducing some of the waste gases at the hearth, so that, in any case, the reducing atmosphere in the furnace will be entirely free from nitrogen.

With regard to the results that may be expected, but without too rigidly anticipating effects or entering into theoretical speculations, it may be said that a reduced consumption of fuel, greater speed in the working of the furnace, and increased purity in the products may be looked for. So far as the power consumption in the manufacture of oxygen is concerned, the more highly the blast is super-oxygenized the smaller will be the volume it will be necessary to heat. On the other hand, although only actual experiment can decide the point, it may be necessary to heat the blast to a lesser degree. There would, therefore, be a certain amount of waste gas available. If it be found possible to work with pure oxygen it will not be necessary to heat the blast, in which case the gases available will supply considerably more motive power than will be required for the production of the oxygen.

To this must be added that enormous quantities of nitrogen will be available, the utilization of which will more than defray the expenses involved in the manufacture of the oxygen.

JACKHAMER DRILLS FOR FOOTWALL WORK ON THE RAND

The following report of work done on the Witwatersrand and G.M. Co., Ltd., shows what can be done with small hand machines when there is scarcity of native labour. Six Ingersoll B.C.-23 hand rotation jackhamers ran on the Witwatersrand G.M. Co., Ltd., for five months from July to December, 1912, continuously, taking up footwall in hard bastard rock. The method of handling the drills was to allow one drill, weight 54 lbs. per native, on contract at 1d. per foot drilled, with one jumper carrier and a white boss on each three machines. The average footage obtained per drill per eight hours' shift was 28.7 feet, the average depth of hole drilled being four feet, the most suitable to the mine's working condition. These six drills have been responsible for 150 tons of footwall broken per day during the period. This includes block holding or re-drill ing broken rock, which was too big for handling. The mine authorities express themselves completely satisfied with the work done, which is peculiarly significant in view of the present shortage of native labor.—*South African Mining Journal.*

PERFORMANCE OF THE JACKHAMER IN BUTTE SHAFTS

The "jackhamer" drill is becoming increasingly popular for shaft sinking in Butte, where the rock is favorable (A. I. M. E. Bulletin, August, 1913). It is found that in either too soft or too hard ground, however, certain difficulties are encountered. In soft grounds the holes are likely to plug. Difficulty from this source is made less serious at the Pittsmont mine by placing a hole sidewise in the steel about 1 in. from the end of the bit, so that if the end hole becomes plugged the air, passing out through the side hole, keeps the drill-hole clean above the last inch of the drill. In soft rock the drill bits are enlarged so as to take 1¼-in. sticks of powder; but in hard rock if the bits are so enlarged, drilling is too slow, and when not enlarged the smaller powder will not break the bottom clean. It is suggested that a more powerful drill of the "Jackhamer" type might prove satisfactory in hard rock.

TEST OF PNEUMATIC ASH-HANDLING

An official test of a pneumatic ash handling at a Chicago pumping station is described in a department report for 1912. The system comprises a Green rotary positive pressure blower and an 8 in. conveyor pipe, which carries the ashes from flat hoppers in front of the seven boilers in the station to the separator tank, from which point an 18-in. exhaust pipe leads to the dust collector. The conveyor duct consists of 212 ft. 6 in. of horizontal pipe, 45 ft. 6 in. of vertical pipe and four 90-deg. elbows of 15-in. radius.

When the test was made the ashes were first weighed and were then hoed into the opening of the conveyor. At boiler No. 2 655 lb. of ash were fed into the conveyor in two minutes, which is at the rate of 327 lb. a minute. As these ashes weighed 44 lb. per cubic foot, and as the boiler is at the far end of the conveyor pipe, several seconds elapsed before they were carried through. At boiler No. 6 the ashes were lighter, averaging 38 lb. per cubic foot: 894 lb. of this ash were fed to the conveyor in two minutes and fifty-five seconds, and were at once carried through.

Liquid hydrogen is the lightest liquid known to science; its density being only one-fourteenth that of water.

THE EVERLASTING MINE PUMP

BY BERTON BRALEY.

I chug and chug the whole day through
As faithful as I "oughter,"
I always have my work to do
To clear the mine of water.

The mine cars rattle to and fro
In noisest endeavor,
But mine cars come and mine cars go
While I go on forever.

By day and night, by night and day
My valves have throbbed and thudded,
And I must keep right on that way
Lest all the mine be flooded.

The cage may sometimes quit the job
And men can use the ladder,
But if for long I ceased to throb
Few breakdowns could be sadder.

But I am here to stop the flow
With strength that wearies never,
And while the cages come and go,
Still I go on forever.

The miners dig the buried coal
Whatever depth it lurk in,
But I must see the "deep black hole"
Is dry enough to work in.

For if they had to swim I know
'Twould bother their endeavor—
So miners come and miners go
But I go on forever.

I am not "fair to outward view"
I never was a beauty,
My lines of loveliness are few,
I'm built for heavy duty.

I know my humble job, and so
I make my best endeavor,
For men and mules may come and go,
But I go on forever.

New methods supplement the old,
New tools and new inventions,
New men the reins of power hold,
The mine has new dimensions.

I note how wise the bosses grow
How up-to-date and clever,
But men and methods come and go
While I go on forever.

—*Coal Age.*

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EVERYTHING PNEUMATIC

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IMPORTANCE OF ROCK DRILLING*

BY W. L. SAUNDERS.

It has been estimated that the value of the mineral product of the United States is about $2,000,000,000 a year; that about $25,000,000 is expended annually for explosives and that about double this sum is paid in wages where blasting is done. The value of the mineral products does not adequately express the importance of the industry involved in the excavation of rock and ore because of the enormous sums of money expended in tunnel driving, in quarries, and in open-cut excavation generally. We know that the Catskill Aqueduct in the neighborhood of New York, which is now nearing completion, has cost some $165,000,000 and that about one-third of this may be rated at rock excavation. These illustrations are given in order to call attention to the great importance of an industry the extension and development of which in our industrial life depend so much upon the economics of rock drilling.

Reference has been made to the new Catskill Aqueduct. There are three aqueducts leading into New York, each built at periods separated by some 20 years of time. The first one, known as the Old Aqueduct, conveys the waters of the Croton river to New York City in a manner which reminds one of the old Roman aqueducts, the ruins of which are still in evidence. The engineers who laid out these old conduits sought to direct their lines around the hills and into the valleys, at all times avoiding the rock. When it was necessary to cross a river or a deep ravine, a bridge or causeway was constructed. High Bridge, over the Harlem river, is an arched masonary viaduct differing in no essential features from the aqueducts of the Romans. When the second Croton Aqueduct was built, about the year 1890, the art of drilling rock had been so far perfected, and the use of explosives, through the invention of dynamite, had become so general, that this waterway was planned and executed on straight lines, following rather than avoiding the rock. The second Croton Aqueduct is a tunnel through rock, about 32 miles in length; material gneiss, almost as hard as granite. Its

*From "Rock Drilling Economics," presented at the Butte meeting of the American Institute of Mining Engineers.

construction was made practicable by sinking shafts about one mile apart, thus providing multiple points of attack and also serving to ventilate the headings. This second aqueduct siphoned the water underneath the Harlem river. This 32-mile tunnel was built in five years. The Catskill Aqueduct, now nearing completion, not only followed the rock wherever it was available, but it passed under several rivers and actually conducts its water underneath the Hudson, where solid rock was sought and found at a depth of a quarter of a mile below the surface.

Pliny gives us a description of what, so far as we know, was the first long tunnel driven in the history of the world. This tunnel was about 3.5 miles long and from 6 to 10 ft. in diameter. Forty shafts were sunk in order to expedite the work, and it is said that 30,000 men were employed for 11 years in its construction. The fact that this tunnel and most of the ancient tunnels in the vicinity of Rome were driven through lime rock enables us to understand how it was even possible to build them. Limestone is the easiest material to perforate, and it is likely that here the ancient system of "firing" was used. Firing consisted of building a wood fire close to the rock and throwing water against the hot surfaces, causing them to flake. With lime rock the material would very likely be softened so that chisels might be used to advantage.

What is true of aqueducts is also true of railway tunnels and mines. The Hoosac Tunnel in Massachusetts developed, though it did not perfect, the rock drill. It was said after the completion of this work that only the treasury of a State made it possible to drive this tunnel by machinery. Had the mechanical engineer neglected the study of rock drill economics it is doubtful that any further attempts would have been made to drive hard rock tunnels by machinery, but the Hoosac was followed by the Musconetcong, driven from portal to portal by machinery. Then we have the Palisades, the Cascade, the Busk, and numerous other large railway tunnels made possible because the rock drill had been simplified and made efficient. In Europe the great Alpine tunnels, known as the St. Gothard, Arlberg, Simplon and Loetschberg, one of them (the Simplon) being a continuous tunnel without shafts for a distance of 12.25 miles, were made practicable by the efficiency of the rock drill.

We seldom stop to think how important the rock drill has been in our industrial progress. Dr. Raymond has said that it is the foundation of all the work of the mining engineer. Railroads, even in America, might have successfully followed the foot-hills and hand drilling might have been the feeble substitute for the rock drill in leading through impassible barriers, but railway efficiency would have fallen far short of its present status and the cost of transportation by rail would have been greater than it is at present. In this we are able to see that the civil engineer might possibly have survived without rock drill economics, but not so with the mining engineer. The history of modern mining engineering is closely related to the history of progress in the art of building a rock drill. Our so-called precious metals would have been indeed precious without this valuable auxiliary. The wealth of the world, especially in its gold, silver, copper, zinc, lead and tin, would have been enormously curtailed, limited by an inability to increase the output in proportion to the demand, and further limited by the fact that low grade propositions could not have been worked at all. Examples of this are seen in the Homestake, the Alaska Treadwell, the mines of South Africa, and in most of the important mines of Michigan, which though once high grade are now low grade properties.

W. L. S.

SELECTION AND TREATMENT OF STEEL FOR ROCK DRILLS

The following we abstract from a report, published by the Mines Trials Committee of Johannesburg, South Africa, of a series of investigations made by Mr. Robert Allen upon rock drill steels, the object being to determine the most suitable steel for use on the Rand and to standardize its heat treatment and manipulation.

It was formerly accepted as an axiom that high-carbon steels were the most suitable for rock drills, but Mr. Allen claims that while both of these and alloy steels require a more complicated heat treatment, their drilling results were no better than those of the ordinary medium-carbon steels. Low-carbon steels were eliminated for obvious reasons,

and from the ordinary medium-carbon steels were elminated those that possessed undesirable tendencies, such as flaking, chipping, splitting, undue wear, or if they were generally treacherous. From the analyses of the most efficient steels remaining were deduced formulas for the compositions of the most suitable steels for rock drill purposes. In these formulas the carbon content varies inversely with the size of the steel as follows, this being one of the most interesting discoveries of the investigation:—(*a*) Larger than 1½ in. cruciform, or steel weighing more than 5½ lbs. per foot run, from 0.60 to 0.65 per cent.; (*b*) 1½ in. cruciform, or steel of equivalent weight, from 0.64 to 0.69 per cent.; (*c*) 1 in. octagonal, from 0.67 to 0.72 per cent.; (*d*) ⅞ in. octagonal, from 0.70 to 0.75 per cent. The quantities of silicon, phosphorus, sulphur, and manganese recommended are the same for all sizes of steel, and are as follows:—Silicon, between 0.05 and 0.15 per cent.; manganese between 0.25 and 0.35 per cent.; the total manganese and silicon content not to exceed 0.40 per cent.; total phosphorus and sulphur not over 0.035 per cent., the less the better; alloying element none, except that aluminum might be used as a purifier so long as, in the finished steel, the amount did not exceed 0.10 per cent. As there appeared, from the experiments, to be no practical difference between steels of the same chemical composition, whether made by the open-hearth, the crucible, the Swedish-Bessemer, or the electric-crucible processes, the method of manufacture was optional. Hammered steel showed no superiority over rolled, therefore for rock drill purposes the expense of hammering might be avoided.

For the heat-treatment in the forging and sharpening of drill bits, oil furnaces were found to be superior to coal forges, and an oil furnace specially designed by Mr. Allen was found to give better results. The steels of the compositions recommended above can be heat-treated in a comparatively simple way, which makes a separate tempering operation unnecessary. This method is recommended, and is here given *in extenso*:—(1) The drills, properly cleaned, are heated to an orange-red heat, at about 1,050 deg. C. (1,920 F.), this heat extending a short distance along the drill from the cutting edge—about 1½ in. for a hand drill, 2 in. for a medium-sized machine drill, and 3 in. for a large machine drill. (2) The heated drill is then forged by rapid hammering and dollying, until it has reached a dull red color—about 600 deg. C. (1,110 F.)—the work proceeding as quickly as possible. This operation for a medium machine bit should be taken from about 45 to 60 seconds. (3) The bit, without letting it cool further, is put back into the furnace and reheated to a bright red color—about 950 deg. C. (1,740 F.)—the heat extending along the bit the same distance as before. (4) It is then sharpened and made to gauge, the hammering proceeding strongly and rapidly, until the bit has reached a cherry red color—about 750 deg. C. (1,380 F.)—the color extending in the case of a medium machine bit, when it is quenched. This operation, with a medium machine bit—in the hands of a good tool-smith accustomed to gauging—will take about 45 seconds. Bits made of 1½ in. cruciform steel or larger should be quenched by standing them vertically on a knife-edge support in the water in the quenching bath, so that the drills stand in from ½ in. to ⅝ in. of water. Smaller bits may be quenched by plunging them vertically into the water, and keeping them moving around in a vertical position for five or six seconds, and then standing the drills on the false bottom of the quenching bath and leaving them there until they have become of the same temperature as the water. The removal of a drill from the quenching bath before it is quite cold is liable to produce fracture.

The standardization of the shapes of bits, and the gauging of the bits in both directions, when sharpening drills, are considered important. The expense of sharpening is slightly increased, but this is offset by many advantages; the rate of drilling is increased; the miner's waste of time in selecting drills that he thinks will follow one another properly (but often don't) is avoided; the chance of "fitchering" or deflection of a drill by "slips" in the rock is reduced; also, when the reaming is good, the drill holes can be drilled more cylindrically and explosives used more economically. All the bits used during the experiments were made and sharpened by hand, and it is to be regretted that the investigations did not embrace experiments in the use of machine-sharpened drills, which are automatically gauged. It is pointed out that by close attention to what are usually considered trivial matters many economics can

be gradually effected. When the steel is of suitable composition, lighter drills can be used to bore holes of the same depth; this, in turn, allows the use of lighter drilling machines; less steel has to be handled and sharpened; less compressed air is needed. Incidentally, it might be noted that the use of lighter drilling machines lessens the number of helpers required.

WELDING SUPERSEDING RIVETING

Flame welding is slowly coming into use in our shops, though not in a way to attract special attention as a shop process with great possibilities. But the visitor to some German machine shops begins to be impressed with the idea that riveting and soldering as means of fastening together two pieces of metal are fast passing away.

Not only is flame welding used for the operations with which we are familiar, but for others. Aluminum tanks, pipes, etc., for brewers' and chemical manufacturers' use are flame welded. Nickel is successfully handled under the torch. Cutting tools are being made from low-carbon steel by changing the structure in the oxyacetylene flame. Bases for oil engines, automobile engine cylinders, boiler tubes, pipe, ornamental iron work, are either in the commercial stage of manufacture by flame welding, or are well through the successful experimental stage. The application seems to be as wide as the necessity of joining together or severing two pieces of metal.

In construction work flame welding is being used by plumbers and pipe fitters who are putting in entire piping installations without threaded joints. An instance of this is the five English miles of piping in the Palace of Justice in Coln, put in in 1910. This is iron pipe put together with oxyacetylene-flame welded points. Not a single screwed joint was used.

In general, flame welding is stated to cost but 40 to 50 per cent. of riveting on the same piece. The shop consuming the greatest amount of gas per day for such welding is a government shop in St. Petersburg, working on army and navy equipment.

The interest in the process is further shown by the facts that for six years a journal has been published in Germany exclusively devoted to autogenous welding, an 800 page hand book has sold to some 5,000 copies, and a text book for industrial schools is just entering its second edition.—*American Machinist.*

NEW BOOK

Text-Book on Highway Engineering. By Arthur H. Blanchard, C. E., A. M., and Henry B. Drowne, C. E., XIII + 762 pages, 6x9 in., 234 figures and 4 charts. John Wiley and Sons, Inc., New York. $4.50 net.

The arrangement of this book, by a professor and an instructor in highway engineering in Columbia University, is based largely upon lectures which have been prepared by the authors for their various classes, undergraduate and graduate, and upon their practice as highway engineers in the United States, Canada and Europe. The book is very complete in character and all parties engaged, either as engineers or contractors on this class of work, will read it with interest and profit. The 27 chapters of the book cover the subject very completely and contractors especially will be able to gain a good knowledge of the various kinds of roads which are now being constructed and the plants and equipment employed. The book appears quite opportunely in connection with the present widespread good-roads movement.

A GIRL'S PNEUMATIC STONE CARVING

A monumental yard's claim to distinction may be frequently based upon some exclusive cutting which it may give its customers and which because of its inherent quality, builds business more rapidly, perhaps, than business in this particular line may be accommodated. Such has been the story of the Troy yard at Utica, N. Y. The pneumatic lettering there is done by Agatha Troy, the daughter of the yard's proprietor, and there is simply no use denying that the young woman's lettering draws business. Miss Troy handles the pneumatic chisels with a touch which no man is ever apt to acquire and produces the fine lines with a delicacy that has made a reputation of her father's yard more than local.

Those Ohio monumental men who are finishing their work with "the air" instead of the chisel, find that it not only effects economy but produces a cleaner and better developed effect. Round letters bloom out in good shape and have a more finished effect than when cut entirely with the chisel. The

finishing of letters by air does not seem to be in very general use, but the plan has been worked sufficiently to demonstrate that it is a good one.—*Granite, Marble and Bronze.*

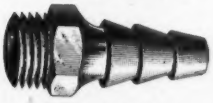
THE POWELL AIR GUN

The device here shown is not new and the name of it is hardly a correct one. It does not go off with the suddenness of a gun but it does its work quite as effectively. Little real work is done in the world without more or less blowing, and the blower should be at hand. The air compressor is now employed in all industries and the portable air jet is one of its most necessary accessories. Press your thumb on the bottom and it blows hard or gently and as long as you wish. It is made to all the standard pipe sizes, from ⅛ in. to 1 in. and nozzles are furnished according to the work to be done. The William Powell Company, Cincinnati.

BENT NOSE TIP.

HAT MFRS. TIP.

BUTTON HEAD TIP.



HOSE NIPPLE.

NOTES

Cement gun coating as a protection for metal immersed in sea water has been tested by the Isthmian Canal Commission at Panama. Plates have been coated with ½, 1 in. and 1½ in. of concrete, and after eighteen months' immersion the metal has been found to be free from corrosion.

From Brussels the report comes that the Societe de l'Air Liquide and the Societe Metallurgique d'Ougree Marihaye have formed a combination, the object of which is to develop the use of liquid air in connection with blast furnace operation. The new company is to be known as La Societe d'Etudes et d'Entreprises Metallurgique.

The grade of the Butte copper ores, as stated in one of our exchanges, varies with the price of copper, which seems like putting the cart before the horse. In 1911 the ore mined carried about 3¾% copper, while in 1912, with the price of copper higher, the ore averaged about 3% copper.

Six thousand rock drills are now in use in the Province of the Transvaal. Of this number, 5,983 were employed on the Rand at the time the statistics were taken, the remainder being in use in other mining districts of the Transvaal. According to government statistics recently published, the actual number of rock drills in commission on the Witwatersrand was 9,018.

Celluloid, as is well known, is almost as inflammable as gun cotton. Chemists have been striving to discover a way to make it less easily ignited, and it is said that they have at last succeeded. Dr. Clement Botrelle has used ether for forming the union of camphor and nitro-cellulose which results in celluloid. The ether evaporates and leaves all the cellulose fibres coated with silica, and non-inflammable.

"Men handling dynamite cartridges with bare hands," says Philip F. Stephens, "often experience severe headaches. Nitro-glycerin is absorbed through the skin and taken into the blood and, being a powerful stimulant, it produces the above malady. This may be avoided by wearing leather gloves doing the work. As the gloves become saturated with nitro-glycerin they should be replaced by new. The gases from the explosion when inhaled also cause headaches."

Two Terry turbine-driven forced draft blower sets, which are probably the largest in point of horsepower in the world, are about to be installed at the Rhode Island Company's power plant at Providence, R. I. Each unit consists of a 600 h. p. Terry Type C-HS turbine, driving through a set of Faulk reduction gears, an American Blower Com-

pany's No. 11 double-inlet Sirocco blower. Each unit has a capacity of 250,000 cubic feet per minute and supplies draft to mechanical stokers. The turbines run at a speed of 3,370 revolutions per minute, the blowers at 460 revolutions.

To reduce operating expenses the United States Mint at Philadelphia will use gas as fuel instead of oil. It will require 30,000,000 ft. of gas a year to melt the bullion from which the coins will be made. Heretofore nearly 240,000 gallons of oil have been consumed annually.

In one or two mines of the Central Rand a considerable saving in "lashing" boys is being effected by imparting a swing to shaking shutes through employment of a hammer drill. The machine is operated at a slow stroke and each stroke of the piston gives the hanging trough a sharp swing, thereby causing the rock to gravitate down to boxholes. We witnessed one such mechanically operated shute at work in a large stope in a deep level mine during the week, and we were informed that a saving of six boys was being effected through substitution of mechanical means for hand labor. In these times of labor shortage the idea, it would seem, might be profitably extended along the Reef.

The following rule is said to have been given recently by the service manager of one of the tire companies: "Inflate the front tire to a pressure in pounds equal to 17 or 18 times their cross-section in inches, and the rear tires to 20 times their cross-section; thus 34 by 4 in. tires should have a pressure of about 70 lb. on the front wheels, and 80 lb. on the rear." It is to be hoped that the tires turned out are better than the rule, which seems almost absurd. The results given above are apparently obtained by using the diameter of the tube as the multiplier instead of the cross-section, and to make the pressure directly proportional to the diameter would give the smaller tubes less than their proper share.

A monster blast in the Boundary District of British Columbia broke down 200,000 tons of ore September 1. The blast was made at the British Columbia Copper Co.'s Mother Lode mine, at Greenwood. For several months previous, in addition to the ordinary work at the mine, the task of drilling 4,830 holes, averaging in depth between 14 and 15 ft., had been going on under the direction of the company's general superintendent, F. S. Norcross, Jr. This system of breaking ore was begun in 1911, but for dimensions this latest blast exceeded all others that have taken place in the history of the mine. Electricity was used to fire the charges, which were connected by 16 miles of wire, and consisted of 24½ tons of 40% dynamite.

At the automobile testing plant of the Worcester Polytechnic Institute, Worcester, Mass., a speed record of 3,310 revolutions per minute for an automobile motor was recently established. The conditions under which the tests were made approximated, as closely as possible, actual service conditions on the road. A dynamometer indicated that the 20 horsepower rating of the motor was reached at 1,120 revolutions per minute. At 1,900 revolutions per minute 30 horse-power was developed, and at the maximum speed 3,310 revolutions per minute, 36 horse-power, which was equivalent to a speed of 89 miles per hour, was developed. At about 3,300 revolutions per minute the power curve began to drop.

Danger of spontaneous combustion in coal has been the subject of a recent German experiment. Coal is divided into four classes of danger. The coal is pulverized for the tests, then moistened, passed into a tube containing CO_2, and dried. The coal after drying is then heated in a current of oxygen until it ignites, the temperature as also the time needed to ignition being recorded. The temperature at which the coal ignites, after being an hour in the oxygen, is called the initial temperature, and should be 150 deg. as a minimum. Any coal which shows no increase in temperature after this one hour, or else only a slight increase, is termed in the safe class. The coals in the danger class burned after exactly 60 minutes in this temperature and showed a considerable increase in temperature. The degree of brittleness is also said to be an indication whether the coal is dangerous for transportation or not.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

SEPTEMBER 2.

1,071,692. DESICCATING PROCESS. CHARLES H. BRIGHAM, Brooklyn, N. Y.

1. The process of obtaining the solid constituents of liquids and semi-liquids in the form of a substantially dry powder, which consists in converting the mass into a fine spray and surrounding the spray with an envelop of forcibly projected air introduced under pressure moving in the same direction with the spray.

1,071,713. REFRIGERATING-MACHINE. WILLIAM F. DAVIS, Portland, Oreg.

2. In a refrigerating machine, the combination of a condensing chamber, cooling means disposed therein, compressing mechanism, means to conduct compressed gas from the compressing mechanism to the condensing chamber, a pipe to deliver gas to said compressor, an oil pipe connected with the lower part of the condensing chamber, and also connected with the said pipe to deliver oil thereto, an oil filter through which the oil passes before delivery to said first-named pipe, and a strainer located within said compressing mechanism through which the admixed oil and gas pass.

1,071,727. METHOD OF AND APPARATUS FOR DRAWING GLASS. ROBERT L. FRINK, Cleveland, Ohio.

1,071,771. PRESSURE-REGULATING APPARATUS. EMBURY MCLEAN, Brooklyn, N. Y.

1,071,777. FLUID - PRESSURE - REDUCING VALVE. HOWARD M. P. MURPHY, Pittsburgh, Pa.

1,071,876. PUMP FOR SPRAYING DEVICES. LAWRENCE M. CAMPAU, Oconto, Nebr.

1. A pump for spraying devices comprising foot pieces adapted to be secured to the respective feet of the operator, air compressors in the form of bellows attached to the respective soles of said foot pieces, valve controlled air intake pipes communicating respectively with said compressors and having their free ends supported above said foot pieces, and an air educt pipe adapted to be connected to a pressure tank and having a valve controlled branch leading from each of said air compressors whereby a constant pressure is created in the pressure tank.

1,071,878. PNEUMATIC PUMPING APPARATUS. ADAM EDWARD CHODZKO, Los Angeles, Cal.

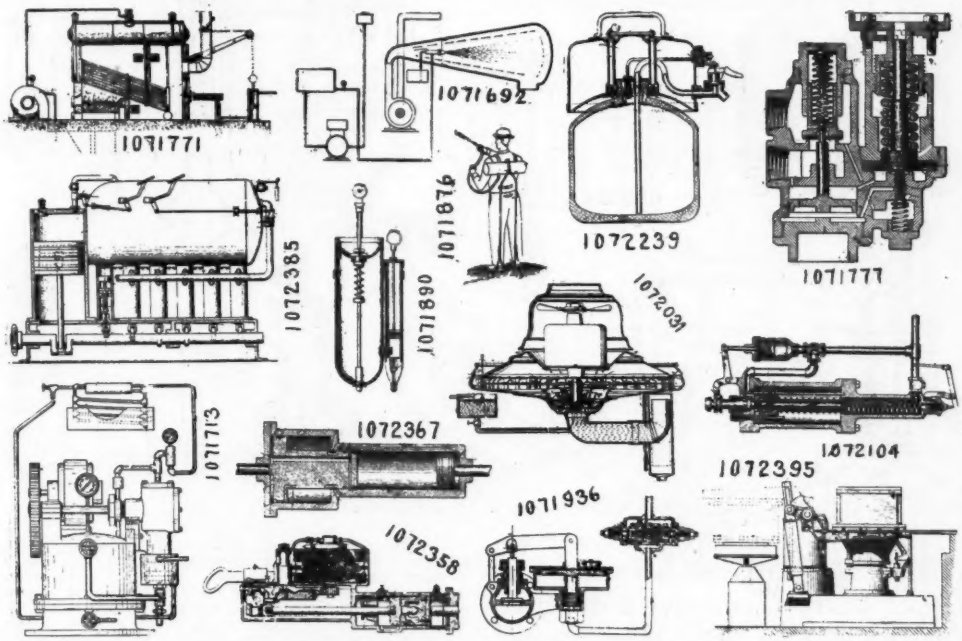
1,071,890. LIQUID-DISPENSER. JOHN DESMOND, Chicago, Ill.

1,071,929. AIR-PUMP. JOSEPH E. LAFORCE, North Grafton, Mass.

1,071,931. VACUUM-MASSAGE. WILLIAM J. LONG, St. Louis, Mo.

1,071,936. AUTOMATIC VACUUM-GOVERNOR. FRANK J. MATCHETTE, Milwaukee, Wis.

1,072,031. ATOMIZER OR HUMIDIFIER. JAMES C. RANKINE, Pawtucket, R. I., and GEORGE H. GOLDSMITH, Biddeford, Me.



PNEUMATIC PATENTS SEPTEMBER 2.

1,072,050. TUNNEL - DRIVING MACHINE. GEORGE F. SPEER, Fort Worth, Tex.

1,072,104. FLUID-PRESSURE MOTOR. JAMES E. EBERSOLE, Palmyra, Pa.

1,072,126. PNEUMATIC CARRIER. WILLIAM H. KOEHLER, New York, N. Y.

1,072,133. THERMAL INTERCHANGING PROCESS. JOEL IRVINE LYLE, Plainfield, N. J.

2. The herein described process which comprises the compression of air, then exposing the said compressed air to the influence of a comparatively cool counter air current, then subjecting said compressed air to the action of a previously refrigerated liquid then subjecting the said compressed air thus cooled to the influence of a current of incoming air and conducting it to the place of use.

1,072,239. SIPHON FOR DISPENSING LIQUIDS. ARTHUR KLEINFELDT, Hoboken, N. J.

1,072,358. FLUID-PRESSURE-DRIVEN TOOL. ALEXANDER PALMROS, Syracuse, N. Y.

1,072,359. ROCK-DRILL WITH WATER-FEED. ALEXANDER PALMROS, Syracuse, N. Y.

1,072,367. DOUBLE-COMPRESSION RECIPROCATING IMPLEMENT. SAMUEL D. SIBLEY, Syracuse, N. Y.

1,072,385. STARTER FOR HYDROCARBON-ENGINES. JOHN F. KELLY, Chicago, Ill.

1,072,395. MOLDING-MACHINE. WILFRED LEWIS and JOHN T. RAMSDEN, Philadelphia, Pa.

SEPTEMBER 9.

1,072,496. AIR-PRESSURE PUMP. EWALD A. RAVES, Auburn, N. Y.

1,072,547. VACUUM-CLEANER PUMP. CALVIN C. WILLIAMS, Philadelphia, Pa.

1,072,553. AUTOMATIC BOTTLE-BLOWING MACHINE. SAMUEL E. WINDER, Waltham, Mass.

1,072,852. METHOD OF RAISING OR FORCING LIQUIDS. HERBERT ALFRED HUMPHREY, London, England.

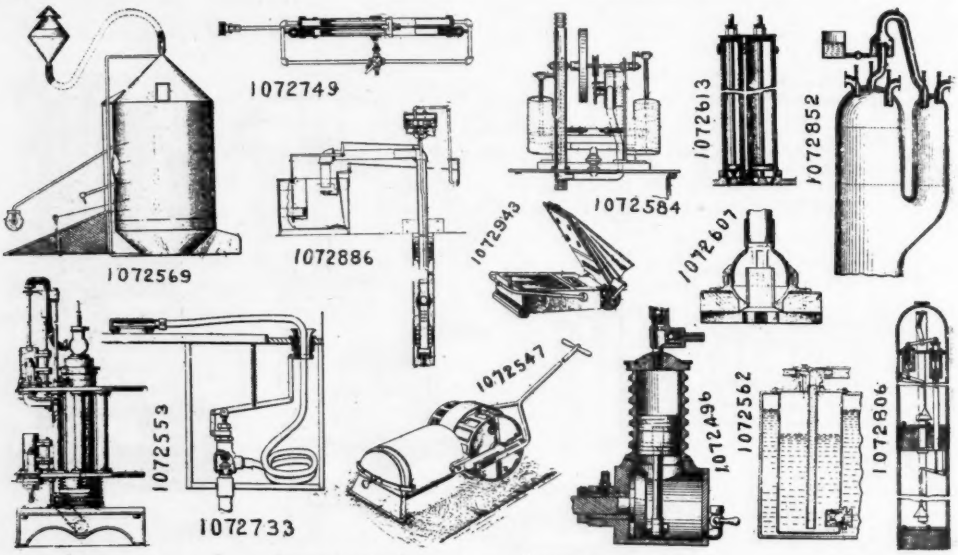
2. The method which consists in reciprocating liquid, the initial movement of the outstroke due to a preliminary expansible charge, utilizing energy derived from said outstroke to force air under pressure, mingled with a combustible into the heat zone of the preliminary expansible charge.

1,072,886. PNEUMATICALLY-OPERATED PUMP. ERNEST NOBLE WARD and FREDERICK JASPER WARD, Baxter Springs, Kans.

1,072,943. SUCTION DEVICE. WILLIAM H. HALL, Cicero, Ill.

SEPTEMBER 16.

1,073,091. MEANS TO PREVENT CONDENSATION OF WATER ON GLASS WINDOWS. THOMAS CARENCE, Kansas City, Mo.



PNEUMATIC PATENTS SEPTEMBER 9.

1,072,562. HYDROPNEUMATIC VALVE. LOUIS DE L. BERG, Watertown, N. Y.

1,072,569. SUBMARINE VESSEL. HENRY G. CADY, St. Louis, Mo.

1,072,576. CONTROLLING DEVICE FOR COMPRESSORS. RUDOLPH CONRADER, Erie, Pa.

1,072,584. MILKING APPARATUS. LAURITS DINESEN, Veile, Denmark.

1,072,607. PNEUMATIC CLEANING IMPLEMENT. SEYMOUR L. GUTHORN, New York, N. Y.

1,072,613. PUMP. CHARLES D. HILL, Rochester, N. Y.

2. In an air pump, the combination with a base and a pair of cylinders attachable thereto by a rotary movement, said cylinders being provided with ports near their upper ends, of oppositely-acting pistons in said cylinders connected together for simultaneous movement, and a tie piece about the cylinders at the ports, said tie piece having internal grooves communicating with the ports and with each other.

1,072,749. PRESSURE-MOTOR. JAMES F. MCELROY. Albany, N. Y.

1,072,783. CLEANING APPARATUS. IRA H. SPENCER, West Hartford, Conn.

1,072,806. PNEUMATIC PUMP. WILLIAM HORACE AUNKST, Milton, Pa.

1. In combination with a window and its frame, an air casing communicating with and located below the window in spaced relation thereto, a valve hingedly connected to the upper end of the air casing and having its free end for engagement with the window, and a vertical strip at each side of the frame, each strip having its outer side hinged to the adjacent side of the frame and having its free inner side extending inwardly toward the center of the window in inclined relation to the latter to deflect the air toward the center of the window.

1,073,095-6. AIR-CONDITIONING APPARATUS. STUART W. CRAMER, Charlotte, N. C.

1,073,139. STARTER FOR EXPLOSIVE-ENGINES. GEORGE HARTWELL KELLEY, Gainesville, Fla.

1,073,149. SAND-BLAST APPARATUS. GEORGE R. LAWRENCE, Cleveland, Ohio.

1,073,159. POWDER-SPRAYER. LEE AARON NAUSS and RAY JOHN NAUSS, Greenville, Ohio.

1,073,175. FLUID-PRESSURE SWITCH. JOHN ALBERT SCHADEL, Pittsburgh, Pa.

1,073,337. VALVE MECHANISM FOR AIR-COMPRESSORS. WILLIAM S. FAIRHURST, New York, N. Y.

1,073,338. VALVE. WILLIAM S. FAIRHURST, New York, N. Y.

1. A sheet metal valve comprising an annular portion provided with two inwardly and oppositely projecting arms each leading from one side of the annular portion to a point adjacent to the other side thereof, the heads of said arms having holes for the reception of guide pins.

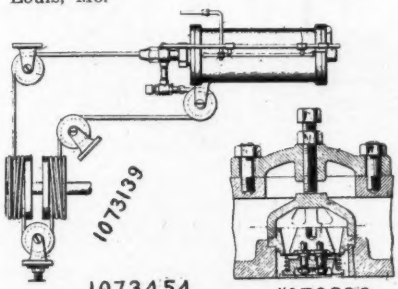
1,073,354. AUTOMATIC AIR-ESCAPE VALVE. CHRISTOPHER LAUTERBACH, Baltimore, Md.

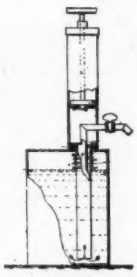
1,073,445. ASH-EJECTOR. JOHN H. SNELLING, Newark, N. J.

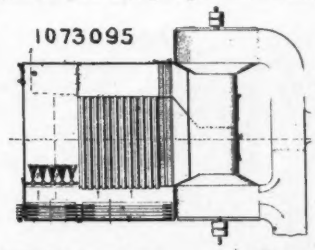
5. In an apparatus of the character set forth, a hopper of tapering form for the reception of material to be discharged, said hopper having a passage in its wall and an upwardly inclined jet-hole leading from said passage to the interior of said hopper, means for supplying fluid under pressure to said passage at the narrowest part of said hopper and jet-hole, and means for leading away the material to be discharged.

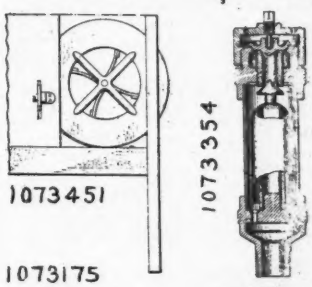
1,073,451. GRAIN-SEPARATING MACHINE. MORRIES WEAVER, Jonestown borough, Pa.

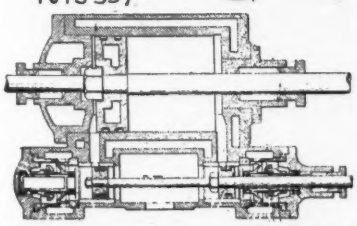
1,073,454. AIR-GUN. ADOLPH WISSLER, St. Louis, Mo.

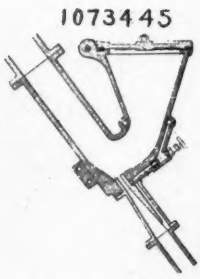


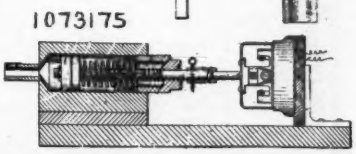












PNEUMATIC PATENTS SEMTEMBER 16.

1,073,474. PNEUMATIC - OPERATED PUMP FOR LIQUIDS. HERBERT WILLIAM COPLESTONE, Bunbury, Western Australia, Australia.

1,073,475. AIR-CONDITIONING APPARATUS. STUART W. CRAMER, Charlotte, N. C.

SEPTEMBER 23.

1,073,609. ARRANGEMENT FOR VENTILATING AND FOR MOISTENING THE ATMOSPHERE OF PREMISES. JEAN FREDERIC PAUL KESTNER and HENRI JEAN EMILE NEU, Lille, France.

1,073,630. LIQUID-RAISING APPARATUS. JAMES F. REDDY, Rochester, N. Y.

1,073,646. ORCHARD-SPRAYING MACHINE. FRED C. THOMPSON, Granger, Wash.

1,073,801. UNLOADER AND STARTER FOR COMPRESSORS AND PUMPS. ERNST FRIEDRICHS, Barmen, Germany.

1,073,840. PNEUMATIC SPRING FOR VEHICLES. TOMAS LUIS DE BEJAR and BERNARDO LANZAGORTA, Habana, Cuba.

1,073,867. PNEUMATIC-DESPATCH-TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.

1,073,872. VACUUM DRYING APPARATUS. OLIVER S. SLEEPER, Buffalo, N. Y.

1,073,876. CLOSED-HOPPER SAND-BLAST. GEORGE F. STEEDMAN, St. Louis, Mo.

1,074,051. AIR-PUMP. FRITZ K. HOHENSTIEN and CHARLES G. MEYERS, Richmond, Ind.

1,074,094. APPARATUS FOR LIQUEFYING GASEOUS MIXTURES. HERMANN BLAU, Augsburg, Germany.

SEPTEMBER 30.

1,074,098. AIR CHARGING AND PRIMING DEVICE FOR SUCTION-PUMPS. JOHN ASTROM, Fort Wayne, Ind.

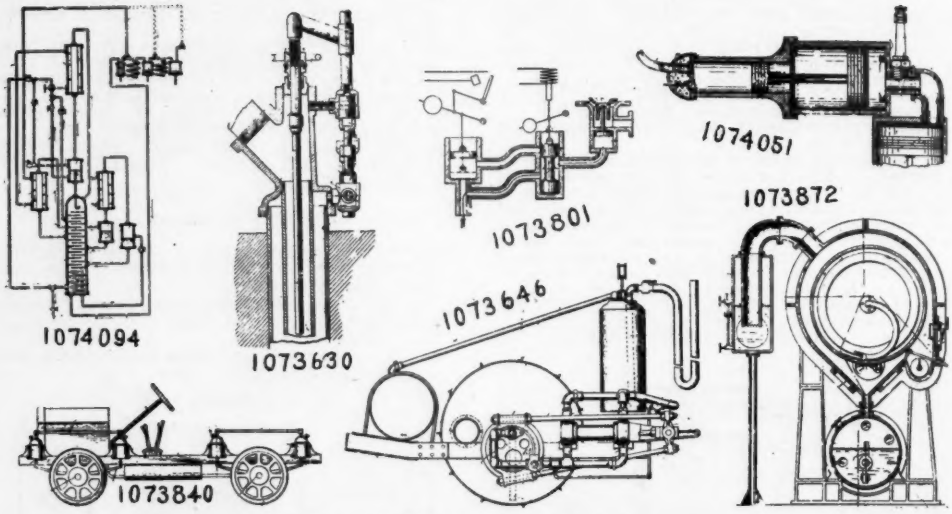
1,074,106. PROCESS OF PRODUCING OZONE AND SEPARATING GASES. HORACE DUMARS, Glen Ridge, N. J.

1. The process of producing liquid ozone and separating air gases which comprises reducing air to a temperature somewhat below the liquefying point for ozone, but above the liquefying point for oxygen and nitrogen, and at such temperature subjecting the oxygen of the air to the action of ozonizing means, and separately collecting the liquid ozone and the remaining gases of the air.

1,074,116. ROTARY PERCUSSIVE TOOL. CHARLES H. HAESELER, Philadelphia, Pa.

1,074,224. DOUBLE-PRESSURE PUMP-GOVERNOR. WALTER V. TURNER, Edgewood, Pa.

1. The combination with a pump governor normally operating at a predetermined maximum degree of pump pressure for cutting the pump out of action and at a predetermined minimum degree of pump pressure for cutting the pump into action, of a valve mechanism operating at higher maximum and minimum pump pressures for controlling the supply of operating fluid to said governor to thereby cause the governor to operate at predetermined maximum and minimum degrees of pump pressure higher than the normal.



PNEUMATIC PATENTS SEPTEMBER 23.

1,074,320. AUTOMATIC FEED FOR PERCUSSIVE DRILLS. CHARLES C. HANSEN, Easton, Pa.

1,074,356. AUTOMATIC AIR-COUPLING. FREDERICK N. FISHER, Columbus, Kans.

1,074,420. SPRING-CLIP FOR PNEUMATIC HAMMERS. JOSEPH F. EISCHEID, Plattsmouth, Nebr.

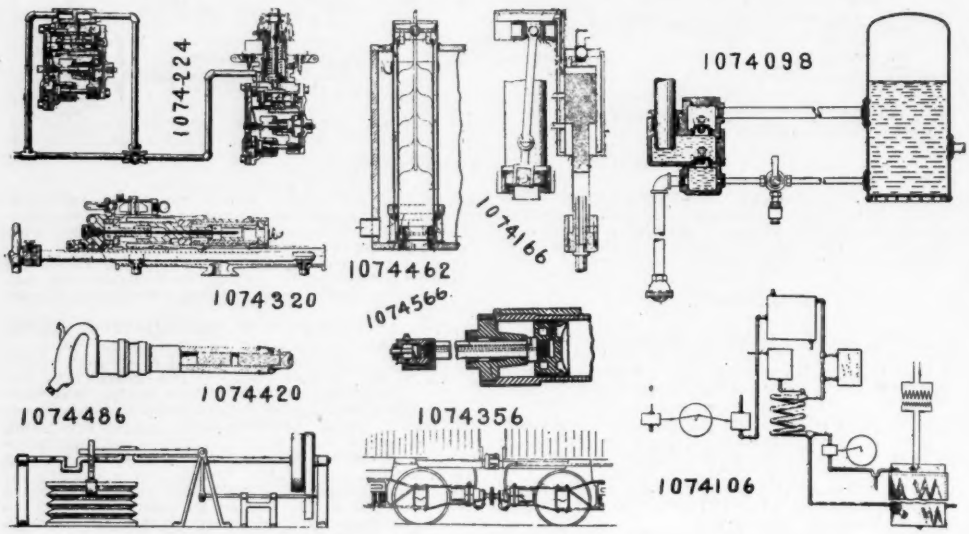
1,074,462. OZONIZER. FRANCIS H. RICHARDS, Hartford, Conn.

1. In an ozonizing apparatus the combination with a pair of concentric tubes having between them an annular space, of a self-adjusting upper ring for the outer tube and having a tube-bearing shelf on its inner side; a lower self-adjusting ring for the inner tube and having a tube-bearing shelf on its outer side; a ring-supporting frame member having an annular lower bearing-surface for the inner ring and ring-supporting bearing-surface for the upper ring, and having side-outlet air-passage space located at a height between the two rings.

1,074,486. AIR-REGULATOR FOR ORGANS. PAUL OTTO BOESKE, Manton, R. I.

1,074,566. RUN-OUT GEAR OF HEAVY ORDNANCE. ARTHUR TREVOR DAWSON, Westminster, London, and JAMES HORNE, Barrow-in-Furness, England.

1. In run out gear for ordnance the combination with the air cylinder, its floating piston and the packing rings of said piston, said piston being subjected to air pressure on one side and to liquid pressure on the other side, of means for forcing liquid into a cavity between said packing rings and for subjecting it to a pressure which is greater than that in the air cylinder.



PNEUMATIC PATENTS SEPTEMBER 30.